FACTS & FANCIES

Professor A. M. LOW

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FACTS & FANCIES

SOMETHING ABOUT
NEARLY EVERYTHING
UNDER THE SUN

BY

Professor A. M. LOW

Author of

"THE WAY IT WORKS"

&c.

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WAR ECONOMY

THIS BOOK IS PRODUCED IN COMPLETE CONFORMITY WITH THE AUTHORISED ECONOMY STANDARDS

DEDICATED

TO

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§I

NATURE

OBSERVATION

Have you heard the story of the pond?

Some years ago three young men walked past a pond and speculated as to the possibility of fishing, until one of them observed the recurrent presence of bubbles.

Ignoring the laughter of his companions, he collected samples of this water and the pond mud underneath. Examination showed that a peculiar type of fermentation was taking place, and he wondered if the germs causing all this excitement could be made to multiply. They could. To-day this method has been applied to commerce with such success that there is at least one big city in England drawing most of its electric lighting from bacteriological overtime. Observation is certainly worth while.

NOT SO STILL-LIFE

Have *you* ever watched a pond for six hours? With a microscope it would look like a state of war. With a high speed cinema speeded up it would suggest a Commando raid, with weeds working hard to tear each other to pieces like trees in a forest. In this sense, all life fights. Very cleverly, for some insects actually paralyse their victims so that by suspended animation they can provide fresh food for grubs. But come back to the pond.

There is a spider who knows that hairs do not sink in soup. He knows that the surface tension among the "electrified" particles that compose all matter, whether it be your hand, or a piece of iron, gives liquids a hard "skin". So Nature has provided him with furry feet. Up he comes to the pond, walks across the water to one side until he reaches the bank. In one "hand" he takes a piece of sand and in the other a

When you cross a common on a hot summer day you will often hear the sound of incessant crackling, just like miniature machine-guns. This is because the gorse seeds are ripe and each pod bursts open with a "pop", scattering them far and wide. If you turn down the hem of your trousers after a long march along country roads you will be sure to find seeds of all kinds that have collected. In one case a man counted 110 grass seeds and those of two other plants after trudging over a rough pasture.

Some plants, like sundew which is to be found in boggy places, eat insects, catching them by means of sticky hairs and then devouring all but the feet. Others are parasites and live on other plants. Dodder is one of the most tiresome of these. It strangles its host with red thread-like tendrils and makes heather or even clover look as if it had been wound round and round with red cotton.

All plants depend to a great extent upon insects for their pollination, and in consequence set out to advertise themselves by their colour, scent, or nectar. There are white sweet-scented flowers that open only at night to attract moths; and others, like the scarlet pimpernel, which shut each day after noon as regularly as clockwork.

Recently, experiments have been made by scientists to discover if it is true that the moon regulates plant growth. It is claimed that certain seeds when sown at full, or new moon, germinate quicker and make better growth than those sown at other times. When we consider that the moon influences the tides, and that certain sea creatures, even when taken out of the water, order their lives according to tides, there seems no reason to doubt that in some as yet unknown way it also affects plants.

TELEPATHIC INSTINCT

In July or August, if you are lucky, you may see a large brown moth flying very quickly across the open country. This high-speedster is the male oak eggar, off to keep a date

with a lady moth a mile or two away.

Having come out of her cocoon the female oak eggar climbs on to the stem of a nearby plant and sends out, in some way not yet understood, messages to any males within receiving range until at length one arrives to be her mate. Certain flies also appear to signal in much the same way.

The homing instinct of pigeons is perhaps on a different scale. Some have suggested that the bird stores up in its mind all the changes of direction to which it has been subjected. Others say that sight is to some extent necessary.

DANCING BEES

Bees are such fascinating creatures that any facts about them should be welcomed. Recent experiments over a number of years have actually proved that when a bee makes a good "find" of honey, it executes a kind of ceremonial dance which conveys somewhat mysteriously to any of his comrades within reach that it is "on to a good thing." In a short time another bee will arrive, in turn taking part in this dance, until at last all the other bees within a fair distance have been called to the feast. Whether these strange movements set vibrations going which are easily picked up by bees has not yet been ascertained.

PUTTING OYSTERS ON PEARL PRODUCTION

Any expert can tell a "cultured" pearl from a real one, because only the outer skin of the former resembles the natural variety. The Japanese are past-masters in this art of cultivation. They take young oysters ("spats") and keep them in sea cages. When three years old sacs containing small spherical beads are grafted on to the spats and they are then put into the sea again for seven years, during which time they build a secretion round the bead which forms the pearl. In spite of the fact that thousands of oysters are operated on each season only 60 per cent yield pearls, and of these only 5 per cent are marketable.

TALKING OF FLIES

Here are some rather odd facts about ordinary flies, such as we see everywhere every day. They can walk up and down and all about because each foot has two small claws that cling to any tiny crack or crevice, and as the insect alights a sticky secretion on the foot-pads helps it to stick to whatever surface it happens to be on. Another queer thing about flies is that they have mosaic eyes that break up the world as they see it into innumerable spots, which must make it a most bizarre affair. Fireflies, as you know, emit cold light, but a whole fieldful of them would hardly light a single room, for each insect only generates about twenty-five-thousandths of a candlepower! You can estimate for yourself how many could beat the black-out.

THUNDER AND LIGHTNING

Thunderstorms are mostly caused by the unequal heating of vast masses of air, or by friction, resulting in a great difference of the electric potential between them. The electricity is discharged as a great spark; and the noise of the thunder is due to air rushing into the vacuum thus caused, the rumble being the echoing and re-echoing of the original crackle.

It has been calculated that the energy represented by a single flash of lightning is at least sufficient to drive a train at 50-m.p.h. for an hour. Since hundreds of storms are always taking place every minute of the day somewhere in the world, it is obvious that lightning is a tremendous source of power. The energy is not, even now, entirely wasted. When an electric spark is passed through moist air, the nitrogen combines with the oxygen and with the water forms nitrates. These are very valuable fertilisers and the value of them to the land represents millions of pounds in a year.

There are many myths about lightning. One of them is that it never strikes twice in the same place. Perhaps the origin of this was that no man was likely to live to tell the tale!

Tall buildings have been struck many times in a single storm. Another myth is that there is such a thing as a "thunderbolt". This may have originated in damage done by lightning which may be not unlike that of the damage caused by a missile, or to the coincidence of a meteor falling during a thunderstorm.

Many deaths occur every year through lightning. They could all be avoided by the simplest precautions, based on understanding the most elementary principles of electricity. The most important of these is that an electric current or discharge takes the easiest path. In the case of lightning this may be represented by tall trees, and therefore you should never shelter from the rain under trees. Better to be wet than electrocuted.

The tallness of the object is comparative—a small shed on a flat moor, or a steel fence in flat fields, may be as dangerous as tall trees in ordinary country. Metal always provides an easy course for lightning—therefore avoid touching or being near large masses, such as an iron fence. It is even best to avoid holding metallic objects, such as a knife or spade. But it is a myth that mirrors are dangerous and attract lightning. The idea probably originated in the reflection of the flash.

When lightning strikes a person it may cause astonishing injuries or provide remarkable escapes. These are not "miracles", but due simply to the laws of electricity. Metal objects may be melted—even a watch-chain provides a quicker path for the lightning. The torn clothes which are sometimes stripped from a body have been explained by the explosion of steam caused by the tremendous heating of moisture on the body.

Light travels at a speed of 186,000 m.p.h., sound at 1100 ft. per sec. So you can easily count the seconds between a flash of lightning and the noise of thunder to estimate the distance of the storm.

WEATHER SIGNS

WEATHER forecasts are not published in wartime as they might be of value to the enemy. They are still made, of course, for the benefit of our own forces, but known only to those directly concerned.

To a certain extent you can be your own forecaster. Long before meteorologists discovered depressions and began to draw maps with isobars or isotherms, men foretold the weather by various signs. Some of these were pure superstition. Others have been confirmed by scientific observations. They are worth knowing, for even in these days weather is a local matter. The general forecast cannot deal with individual districts and a difference of a few miles may make a great difference.

One of the things to watch is the type of cloud in the sky. Cirrus clouds—those rather wispy clouds which are not very high—often precede a frost in the winter months.

Another type of cloud is cumulus, heavy cloud that often changes quickly. This portends showers; but if it persists after sunset it may herald a period of thoroughly unsettled weather. The old weather prophets put it: "Blue to white—rain's in sight."

The direction from which the clouds come is all-important. If changes in the sky come in from the north or easterly directions they are often deceptive, and a great amount of fine cloud may mean no rain or even break in a fine spell. Rain generally comes from the west and south. The exception is snow, which may come from the south-east as well as from the north.

Colours help to provide forecasts. The colours may be violent—the coppery colour of thunder, the green of squalls. The old saying has it that a red sky at night means fine weather. This needs qualifying. If the red, accompanied by orange and pink, extends almost overhead, it means rain within a day or so. Incidentally, you may have noticed a dark uncoloured patch below the "twilight arch"

which is pink. This is caused by the shadow of the earth.

Regarding the opposite, "Red sky in the morning is the shepherd's warning", statistics show that this is right less than fifty times out of a hundred. Nevertheless, accompanied by certain types of cloud formation, it seems to be a fairly safe warning of rain within twenty-four hours.

On some occasions in Britain exceptional visibility is a sign of the break-up of the weather. In many localities there is a weather proverb that when a certain landmark is to be seen, rain will follow within twenty-four hours.

Many weather proverbs are associated with the behaviour of animals. Possibly animals are more sensitive to changes in the pressure or the humidity—certainly they do not make forecasts! One can hardly believe that the ducks' visit to the fields before rain, in preparation for the snails they know they will find, indicates their direct ability to forecast weather. Probably they are sensitive to the moisture in the air. A pig preparing its bed of straw and getting restless is taken by farmers to indicate the coming of a storm.

Birds move their quarters and alter their behaviour in accordance with the weather. Opinions differ whether low-flying swallows really indicate a coming shower; but grouse certainly seem to go higher in the hills before rain, in search of drier cover. Few animals or birds like thunder and all seem to be aware of its approach. Fish, as every angler knows, will not rise with thunder about. This is not much help, however, as even human beings are conscious of the heaviness that precedes a thunderstorm.

Many flowers are weather prophets. It is said that when the little pimpernel opens in the morning the day will be fine; if it closes before afternoon rain is coming. Clover contracts its leaves during rain and many countrymen can feel a difference in the leaves before the approach of rain. The little white flowers of chickweed are said to open fully before rain.

gelatine and the flies in both boxes lose much of their rate of growth and birth.

Will this, one day, explain our relationship with insects, tell us we live outside our skin, that all matter is alive, and explain why it is that the influence of our life seems to extend beyond our skin?

DEW-PONDS

Dew-ponds, as their name implies, depend on dew and not rain for their maintenance. If you have walked over the South Downs you have probably seen several of these isolated ponds designed by Neolithic man to provide water for his herds on the waterless downs.

To-day, there are still men who construct dew-ponds and claim to have a secret method handed down to them through many generations. Briefly, a space is hollowed out in a suitable spot and then covered with a coating of dry straw. This in turn is covered by a layer of finely-puddled clay and then closely strewn with stones. The larger the pond the quicker it fills, even if no rain falls.

The ponds fill in this way. On the top of the downs in summer the earth stores up heat, but the pond protected by the straw from the heat is also chilled by evaporation from the puddled clay. At night the warm air is condensed on the clay surface and as condensation is greater than evaporation, the pond, night by night, fills up.

If the straw layer gets wet the dew-pond will no longer attract the dew for it then has the same temperature as the surrounding earth and will not act as a non-conductor of heat.

SLEEPLESSNESS

When you lie tossing on your bed unable to sleep, do not think to yourself I wish I were asleep for no one has ever observed the exact moment of sleep. Rather think I want to be sleepy. To warm the air entering the nose is also useful. If you are cold try lightly covering the face with a thin wool scarf.

§II

TRICKS

Try These On Your Friends

A QUART IN A PINT POT

"Trying to pour a quart into a pint pot" is one of our expressions for describing the impossible. It is impossible; but you can do the next best thing, which sounds equally impossible—pour a bottle of beer into a glass that is already full of water without spilling anything.

It is quite simple. Your glass of water should be not quite full. Uncork the beer, put your thumb over the mouth of the bottle and invert it. Now lower the neck into the water in the glass, still keeping your thumb in position. When the neck is covered, carefully remove your thumb. The beer will now enter the glass and the water will enter the bottle.

The explanation lies in the difference in weight or specific gravity between the two liquids. The feat takes a little time to accomplish, but might be considered an ingenious solution to the difficult problem of getting a drink of beer when the only tumbler is full of water; although, perhaps, drinking out of the bottle would be simpler.

A FREE GLASS OF BEER

This is perhaps rather a silly "catch", but it is always effective, and the idea that it is silly is most strongly held by those who have been caught.

When you see a friend's freshly-drawn glass of beer on the table, place your hat over it and then say: "If I can drink that glass of beer without touching the hat, are you willing I should have it?"

As it appears that it is quite impossible to get at the beer without touching the hat, the answer is usually "Yes."

Dive under the table, make suitable swallowing noises, and then tell your friend he had better look and see if the beer has gone from his glass. He will immediately lift the hat to see if the impossible has happened and you have drunk the beer through the table-top. As soon as he lifts his hat, seize the beer and swallow it, thus completing the feat of drinking the beer without touching the hat.

The trick is equally effective, of course, if performed with a glass of water—but perhaps not so attractive!

BALANCING THE TUMBLER

This trick is a "dirty" one, a good way of getting a good-humoured revenge on anyone foolish enough to fall for it. To put it over successfully, you want a little patter about a marvellous balancing trick you are going to perform. The only apparatus required is a walking-stick, a pole, or even a rifle, and a tumblerful of water—or beer. Get on to a chair and place the full tumbler mouth upwards against the ceiling. Holding it with one hand, take the stick or rifle and place it under the tumbler, pressing upwards so that the tumbler remains safely in position.

Very carefully lower your grip on the stick, get down from the chair, and continue pressing. The stick's handle will now be just above your head. Quite innocently, ask your victim if he would mind holding the stick for a moment. Once he has got hold of it, you withdraw and the laugh is on your victim, for he cannot move from the spot or relax without letting the tumbler of water crash on to him—and eventually his arm is bound to get tired!

PLACING THE DRAUGHTS

When you have finished your game of draughts and have been beaten, you can get your revenge with the following catch. Take four white and four black draughtsmen in a pile in your hand. Place the top one on the table and the next one underneath the pile, the top one on the table and the

next one underneath the pile and so on until all the draughtsmen lie on the table, when it will be found that they lie alternately white and black.

You are fairly safe in challenging your opponent to copy you and in handing him the eight draughtsmen. Everything depends upon the preliminary arrangement of the draughtsmen in the pile in your hand. Your opponent will probably fall into the trap of arranging them alternately black and white, when they will most definitely not come out alternately on the table.

There is only one way in which you should place the draughtsmen before starting. Reading from the bottom of the pile the draughtsmen should be: black, black, black, white, white, black, white, white.

If there are no draughtsmen, you can do the same trick with eight pennies, alternating heads and tails.

TESTING YOUR LUNGS

Could you blow over a large pile of books with a single puff? You probably doubt it, even if you have a pair of strong lungs. But the power of your lungs is greater than even you imagine. Put an ordinary paper bag under the pile of books, gather it at the neck and give a strong blow into the bag. It will lift the books and, provided the pile is high enough, topple them over.

THE FIREPROOF HANDKERCHIEF

Borrow a handkerchief from one of your friends or, if you fail, use your own, and spread it open over your upturned left hand, so that your hand is completely covered. Now take a lighted cigarette, give it a few puffs to get a good glowing tip and press the burning end into the middle of the handkerchief. Keep it there for about a minute while your friends wonder why you want to spoil a perfectly good handkerchief by burning a hole in the middle of it. Then remove the cigarette and show the handkerchief—absolutely

unburned or hurt in any way by the burning cigarette! Perhaps the more unbelieving of your friends will say that you were not really pressing the cigarette against the handkerchief. If so, you can perfectly safely let them have a turn holding the cigarette—the cloth will remain unburned.

The secret is quite simple. When you spread the handkerchief over your hand you concealed a half-crown underneath. You press the cigarette on to the handkerchief where it is covering the coin. The metal of the coin conducts away the heat so fast that it cannot burn the cloth.

You can try this on a tablecloth with a half-crown concealed underneath. But practise it on an old handkerchief once or twice first or you may find the price of a new tablecloth being docked because you kept the cigarette on it a little too long!

TELLING BY TOUCH

Talking about metal conducting away heat, you can lay half a dozen pennies on a table and undertake that if someone picks up one and holds it in his hand for a minute while you are out of the room, you will be able to identify the penny he chose simply by your sense of touch. Of course if you work this up with some talk about the "aura" which everyone leaves on anything they touch, so much the better.

It is very simple. You feel each of the coins for an instant —and the one that is warm is the one that has been held. Copper rapidly conducts heat from the flesh—that is why it feels cold. The body temperature is about 98°, the air temperature is, perhaps, only 60°, and the difference can easily be detected. If your finger-tips are not very sensitive, lay the coins on the inside of your forearm—where a mother feels the temperature of her baby's bath.

The only warning given is not to try this trick if you are in the tropics. The temperature of the air, and hence of the coins, might be greater than that of the body.

THE BILLIARD BALL RUNS UPHILL

CAN a ball be made to run uphill? Of course not. But what is equally good, it can be made to appear to run uphill! Next time you have finished a game of billiards, take the two cues and lay them on the table so that the two cue ends are together and the butt ends a little apart, the two cues forming a very sharp angle, about the width of a billiard ball wide at the cue end. Of course it is "uphill" from the cue end to the butts. But if you place a ball on the cue end, between the two cues, it will run uphill to the butts.

This is an optical illusion—as the ball moves, the points at which it touches the cues actually drop a little owing to the angle at which the cues are placed.

When thinking of gravity, do not forget that a spring balance and a pair of scales will not give the same weight in all parts of the world. Also that everything falls, apart from air resistance, at the same rate. More scientifically expressed, all bodies fall at the same rate in a vacuum.

NOTHING WANTS TO MOVE

You have probably heard of inertia, which may be very unscientifically defined as the reluctance of anything to start moving. All sorts of tricks depend for their effect upon this fact. The most spectacular, perhaps, but definitely one to be practised carefully, is cutting an apple in two when it is inside a handkerchief, without damaging the handkerchief.

The apple is placed in the middle of the handkerchief, the corners of which are gathered and tied together with a piece of string. The apple and handkerchief are then hung up by the string. The sword, which must be sharp, is brought upwards very quickly, when, if everything goes rightly, the apple will be neatly sliced in two without a cut being made in the handkerchief. But just until you are sure of yourself—use an old handkerchief!

Another effective trick based on the same principle requires only a half-crown and a strip of paper about half an

inch wide. Put the paper on the edge of a table, so that half is on the table. On this stand the half-crown on edge. The problem is to remove the paper without touching the coin or upsetting it. The solution is to hold the paper out tightly with the left hand and with the right give it a sharp blow with a pencil or even the rigid forefinger. The paper should come away without upsetting the coin.

Try this trick. Take a broomstick with a pin in each end, rest the pins on two tumblers of water standing on strong chairs. With a single blow of a poker you can break the broomstick in half.

This is due to inertia.

POWER OF IMAGINATION

THINGS are much easier if you all pull—or lift—together. That is the explanation of this little feat which, on the face of it, appears almost occult.

A big person lies on two chairs, his back on one, his feet on the other. Four men stand one at each corner and endeavour to lift him by placing a hand under each shoulder and under his legs. They will fail.

But if each lifter takes a deep breath and at the same time the person to be lifted takes a breath and gives a signal when his lungs are full, up he goes quite easily. It is not, of course, that the air has blown him up like a balloon, but simply that the lifters all work together on his signal and also, perhaps, because of the power of suggestion. Using a catchword or pretending to touch the "patient's" head with a "magic-finger" helps to make the trick effective.

Many strong man feats depend upon scientific trickery. Have you ever seen one man resisting the pull of half a dozen others, or a horse? The method is to have two stout sticks. Tie the end of a rope to the middle of one stick and give it to two or three people to hold. Give the other stick to two or three others standing opposite and about three feet away, and then wind the rope round the broomsticks two or three

times. Take the loose end, and you are safe in defying the people with the broomsticks to pull against you with all their might. The rope round the sticks acts as a pulley, giving you all the advantage unless your actual weight is very low in comparison.

The lifting trick, in which a very slight girl is supposed to make herself heavy, depends upon the way in which she stands when "heavy". She prevents your being too close and no purchase can be obtained. The leverage is "against" the lifter.

MOVING THE COINS

Any time you happen to have eight pennies—or eight half-pennies for that matter—you can try this puzzle. Lay them in a straight line. The object is to turn the eight single coins into four heaps of two coins each by moving only one coin at a time and jumping over two coins with each move.

It looks easy, doesn't it? But you could take a safe bet that anyone not in the know will take a long time finding the secret. Here it is. Let us represent the eight coins:

1 2 3 4 5 6 7 8

Place coin 4 on coin 7, then coin 6 on coin 2 and coin 1 on coin 3. Finally coin 8 goes on coin 5. There is no other way of doing it.

LIFTING A PENNY

A good training for a steady hand, and rather an amusing feat, is to lift a penny with two pins. The pins are taken one in each hand and the points placed on opposite sides of the rim of the penny. With a little practice you can lift the penny steadily, turn it this way and that. Practice is essential; but the secret, so far as it goes, is to press the pins very hard and hold them so that they form a straight line with each other.

THE LAST MATCH

You have read stories of drawing lots by taking matches—here is a fascinating and skilful game based upon this idea.

Fifteen matches are required and these are arranged in three rows, one with three matches, one with four, and one with eight. The game allows each player in turn to pick up from any one row as many matches as he pleases, the object being to force his opponent to take the last match. That is the only rule—you take one match, two matches, all the matches in a row—but never from more than one row at a time.

The player who has the first move should always make certain of winning the game.

The secret of always winning is to take one match from the line containing eight. If your opponent has first move and does not take "one from the eight", you can be certain of winning by leaving certain positions. If you leave him 2:4:6—1:4:5, or any two equal lines such as 4:4, he cannot win.

TRY THIS KNOT TRICK

Can you tie a knot in a piece of string without letting go of the ends? All you have to do is to cross your arms. Pick up an end of the string in each hand, still keeping your arms in the crossed position. Then merely slip one arm through the other till they are uncrossed and the string will remain in your hands with a neat knot in the middle.

TRY YOUR HAND AT HYPNOTISM

Get a friend to sit comfortably in an easy chair, resting his arm loosely on the table. Then tell him that by gently stroking along the top of his arm and the back of his hand you will shrink the muscles so that gradually his arm will rise from the table, resting upon the elbow. Start stroking and say every now and then, "Do you feel it getting lighter?" Pretend to look underneath to see if it is rising, and in a

short time up will go the arm as the result of your suggestion —in nine cases out of ten.

THOUGHT-READING SYSTEMS

Thought-reading or telepathy may one day be possible. As far as we know at present, our powers are exceedingly limited. However, this need not deter you from demonstrating thought-reading to an audience, provided you have a confederate.

The method is to have a simple code. When an article is handed to you and you ask your confederate questions about it, or talk to the audience, your words form a code. The simplest is that for giving the date on a coin—only ten words are required, one for each number, and these should be words with which it is easy to begin sentences. For instance, "the" could be 1, "hurry" 2, "now" 3, and so on. Having seen the date on the coin yourself, you proceed to talk to your assistant. "The penny I have should be easy for a great thought-reader like you," and he knows the date starts with 1. "Hurry up," and he knows the second number is 2, and so on. Actually, the matter can be cut down very much, since all likely coins start with 1, and 8 or 9 is almost sure to be the second figure. You can arrange similar codes for other things, such as colours, etc. If you take up these simple codes one by one, you will be amazed at the amount of information that can be passed without the audience guessing anything.

A childishly simple thought-reading trick is for the thought-reader to go out of the room while someone gets up and touches an object. The demonstrator (chosen for the power of his mind!) but really an accomplice, asks the thought-reader, "Was it this?" "Was it this?" pointing to various objects. At last he points to the chosen object and says, "Was it that?" and the thought-reader, after appearing to give it thought, says, "Yes." Here the simple clue is that it is "this" for any object not touched, "that" for any object chosen.

Another simple thought-reading deception works if skilfully manipulated with a fair number of people—less than ten is risky. Each person writes on a piece of paper a question and the thought-reader collects them after they have been folded over so that he cannot see the writing. He holds one to his forehead, appearing to thought-read it, then answers the question, picks up the next, holds it to his forehead and answers that, and so on. Finally, he asks if everyone has been answered and they agree. They completely overlook the fact that the first question he answered was his own—or any imaginary one. Then when he opened the paper apparently to check and see if he was right, he really read the next question—but of course, care must be taken to hide the papers from prying eyes! If you have a little pure alcohol on a pad, you can wipe it over an envelope containing the paper to be read; the paper becomes temporarily transparent!

CIGARETTES ARE STRANGE THINGS!

Light one and begin to smoke it. When smoked to the butt —and who doesn't—let it drop. You will find that it usually falls butt downwards, for this is the heaviest end, being wet. Throw one out of the window of a train and it appears to stand still before rushing away. This is because air sticks by friction to the train to some extent; it has nothing to do with relative speed of the train to the earth.

BEND WITHOUT BREAKING

Here is a good trick with a cigarette to show your friends. Begin by asking them if they can bend one in half without breaking it. When they try, their cigarette will almost certainly break badly. You, however, after casually moistening the end of your "fag" between your lips, merely light the moistened end. The vapour will soften the paper and the cigarette can be bent as you wish without breaking.

A BLINDFOLD TRICK

Try this. Blindfold yourself really thoroughly and see if you can tell if your cigarette is burning or not when someone else puts it to your lips.

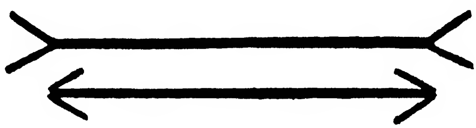
If you are a confirmed smoker it will not be easy to detect.

Incidentally, stage blindfolding is often easily overcome by lifting the eyebrows several times. Then look down your nose.

DO MY EYES DECEIVE ME?

One often says this, knowing quite well that we think not. Yet are we always quite right? What about this.

Which of the two lines shown below appears to you as the longest? Well, you are wrong, for they are both exactly the same length. The mental suggestion that the lower line is the shorter is strengthened by the addition of the extra strokes. But if you don't believe me, measure them and see! Most people draw a top-hat higher than it is wide. Here again, they are wrong.



"HARDNESS" DEPENDS ON SPEED

A man falling out of a high-speed boat may break his leg. Water is hard at high speeds, so is air, and at high pressure an air jet will support a brick, like the ping-pong balls on the water-jet at a fair.

If a modern aeroplane was painted instead of glossed it might reduce its speed by nearly 10 m.p.h.

If a gas-filled electric bulb is hit with a hammer it breaks opposite to the hammer—due to the jerked gas column.

MATCH-LESS

Metallic potassium decomposes water into hydrogen. Put a small piece of potassium in the end of your cigarette and you

ONE MATCH LIFTS FIFTEEN

A good trick is to lift 12 or 15 matches with one. This is done by laying a single match on the table and the others across it with their heads alternately one way and the other. Then put the last match over the first one. It will not touch it as the other matches have been laid between. Now, if you take the first match by the end and lift it up, you will find that instead of all the matches tipping off, they will be held firmly in position and can be lifted up without difficulty. They form a cross, being prevented from falling by the last match placed across the top.

BALANCE

A good balancing trick is to get a friend to stand about two feet from a wall and then place a stool against the wall in front of him. Then ask him to pick up the stool and come back to an upright position without bending his knees. The result is almost sure to be a fall, for the centre of gravity is brought so far forward that it is hardly possible to get upright without overbalancing.

IMPRESSIONS

Some black and white patterns, when spun round and round, give an impression of colour; this is because the shape-seeing parts of the eye become irritated and send 'signals' to the colour-seeing portions of the retina. The retina is the mosaic sensitive plate of the eye in this case.

§III

SOME PROBLEMS

DO YOU KNOW——?

In a rifle the spin of the bullet gives it a gyroscopic effect. It uses the earth's motion. Should rifles therefore be corrected differently for use in England than for service in Australia? It is like the bath-water problem—does the water swirl in the plug-hole in different directions for England or Australia?

* * *

Would a balloon rise if "filled" with a vacuum? Yes. A vacuum is lighter than hydrogen and the air displaced is the same if the balloon is assumed not to collapse.

* * *

If all objects fall at the same speed apart from air resistance why does a piece of paper fall slower than a penny? It does not. Try it with a small piece of paper on top of the penny. A man jumping from a plane seldom exceeds 150 m.p.h. Air resistance holds him back, even before his parachute opens.

Put a bird in a box and balance it on a pair of scales. What happens when the bird flies off the floor of the box? The bird is still there but in flying it drives down a weight of air equal to, or more than, its own weight. What happens to this air? Are the scales unbalanced?

An ornithopter is a flapping wing aeroplane; a helicopter is a plane lifted by revolving airscrews.

The autogyro has a revolving plane, but this plane, in its form of an airscrew, is not power driven except for taking off.

What kind of clock tells the right time at the North Pole. Any clock. Ordinary time does not change.

Which way should a house face to look towards the South, at the North Pole? Any way. It all looks South.

Where would one go to jump the highest? On the equator where gravity is the same as usual (approx.) and where the centrifugal force of the earth's rotation tends to throw the jumper.

Why does the steam from a train seem to be cut off sharply at the last carriage? Because there is a slight vacuum behind the train and the rarefied air helps the steam first to evaporate (steam is invisible until partly condensed with water) and then to disperse.

What drips out of a car exhaust pipe? Water—result of hydrogen and oxygen burning. In a well-run car, carbon dioxide (an inert gas), also comes from the exhaust. Carbon monoxide is a poisonous gas resulting from too rich a mixture. It indicates waste.

If a man fires a gun and telephones to an observer as he fires, why does the observer sometimes hear the word fire and then hear the gun twice? Because the telephone signal travels electrically at the speed of light while the gun noise travels first through ground and then—more slowly—through the air.

All speed is relative. Remember this when asked if the bullet hits the engine driver when fired from the back of

the train at 60 m.p.h., on a train travelling at 60 m.p.h. Of course it does. The train is a world on its own and relative to the earth the bullet is moving at 120 m.p.h.

* * *

HOW FAR DID THE DOG RUN?

A MAN had a dog which always used to run towards his master to take his hat, stick and gloves from him when he was returning from the office, the dog running at 10 m.p.h. and the man walking at 4 m.p.h. One day master and dog left office and house at the same time. The dog, running faster than the man walked, met the man not far from the office and of course much more than half-way from the house. The dog was patted, took his master's stick and dashed away, immediately returning again to meet his master a little nearer home. This went on incessantly for an hour, each time the dog dashing back between home and the master, who every time was a little closer to his house. Even at the garden gate the man was met by the dog and all the way up the path the same thing happened, the dog tearing back and forth until at last both reached home together. During all the dog's trips what was the total distance which that dog covered? Quick now! It is quite an easy one to experts in camouflage!

SHORT CUTS WITH NUMBERS

PERHAPS you know a number of short cuts in arithmetic. Most people know that to find out the price per dozen of a single article quoted in pence, you have only to call the pence shillings. These short cuts are worth cultivating—they save time and energy, and make it possible to do sums in your head which you might otherwise have to put on paper. For instance, to multiply by five is quite unnecessary effort—all you have to do is to add 0 to the number and divide by two. To multiply any number up to 100 by 11, simply add the first and last figures and place the total between them—thus 11 times 43 equals 473 and so on.

You can use some of these short cuts for lightning calculations that will astonish your friends. You can offer to make any number written down containing any number of figures, instantly divisible by 9 by adding one figure which he can insert anywhere. Your friend will probably try to stump you with a long number such as 2734568, but it is quite simple. Add the figures as he writes them down—total 35. You simply tell him to add the figure 1 anywhere he likes and the sum will become exactly divisible by 9. The figure you tell him to add is always that which, added to the total you have made in your head, gives a number divisible by 9. For instance, if it had been 32, you would have told him to add 4 (32 plus 4 equals 36—nine 4's).

Here is a safe offer you can make, although it appears impossible. Offer, if someone writes down a set of three figures, to give them three other figures to place underneath and the result of subtracting one from the other—without looking at the figures. The only condition is that none of the figures written down must be the same, i.e. they may write down 937, but not 977.

Again it is quite simple. When they have written down—of course without your seeing them—three figures, ask them to write the same figures underneath but in the reverse order. Now, still without you looking, tell them to subtract one from the other, and add the result together sideways. The result is 18. You do not want to try this more than once, because the answer is always 18, whatever figures are written down.

If they write down . .	735
Underneath it is reversed .	537
Subtract and you get . .	198
Add "sideways", result is .	18

THE YOUNGER AND THE OLDER

If you have two friends with different ages, you can find out that of the older if you know that of the younger. It is done

as follows: Ask your young friend, who has told you, perhaps, that he is 20, to add the age of the older friend to 79—a figure you arrive at by subtracting the age you know from 99. Then ask him to add together the figures in the number he has reached and give you the result, when you will tell him the older friend's age, which you arrive at simply by adding the result given you to the younger man's age.

One example will make this clear. The younger man is 20 and tells you so. His friend is 27, but you do not know this. You ask him to add the older age to 79—giving 106, and add the first figure to the last one or two—total 7. You add this to the 20 you know and you get the older man's age—27.

THE OFFICERS ON LEAVE

Three officers on leave decide to share a room at a hotel. The waiter tells them that it will cost 30s for the three of them and asks for payment in advance. They give him 30s, but when he goes to the office, the waiter is told the price of the room is only 25s so he is given 5s change.

The waiter, knowing the officers had been prepared to pay 30s, returns only one shilling to each of them and pockets two shillings. Thus each officer paid 9s—total 27s. The waiter pocketed 2s, making a total of 29s. What happened to the other shilling?

Solution.—The fallacy in the story, which not one person in ten can see, is that the 27s included the two shillings pocketed by the waiter, and this should not therefore be added to the amount. The 30s was eventually divided as follows: 25s to the cash desk, 3s back to the officers, 2s kept by the waiter—total, 30s.

Solution.—One candle was 1-16th of its length, the other 1-4th (or 4-16ths) of its length. The candles had therefore been burning $3\frac{3}{4}$ hours.

AVERAGE SPEED

It is surprising how many people slip up over the simplest sum in averages. Suppose someone offers you a lift home, twenty miles away, and drives for forty miles an hour for the first ten miles and then, when you tell him to step on it a bit, at sixty miles an hour for the second ten miles, what is your average speed?

Nine people out of ten will reply instantly, "Fifty miles an hour." But the right answer is 48 m.p.h. You take fifteen minutes to cover the first ten miles and ten minutes to cover the second ten miles—total twenty-five minutes for twenty miles, or 48 m.p.h.

This shows how deceptive averages can be. A quartermaster once reported, quite truthfully, that the troops on a certain campaign had been supplied with the average rations. But this did not mean there were no grounds for complaint. Some of the troops had next to nothing while others had double rations. Nevertheless the average was the correct amount!

A GAME FOR ONE

If you like playing games without a partner, here is one that requires nothing but a box of matches. Make a square, having four matches in each side. Now, by inserting further matches, divide up the square into 16 squares, each with a side of one match. If you count all the squares in your figure, large and small, you will find there are 30.

The problem is the remove the smallest number of matches so as to leave not one single perfect square. The best possible solution is 9, and see if you can hit this number before looking up how to do it.

Solution.—There are various ways in which the nine can

be removed, but they will all conform to the following principle. If we call the matches across, starting at the top left-hand corner, a, b, c, d, those in the second row, e, f, g, h, and so on, and those down, 1, 2, 3, 4, *etc., the ones to be removed are e, h, j, k, m, n, p, s across and No.* 9 *down.*

DIVIDING THE MONEY

An eccentric woman decided to divide her money when she died between her two nieces and two nephews in rather a curious way. In her will she directed that the eldest child, a boy, should receive £1 and one-quarter of the remainder. The second child, a girl, was to get £1 and one quarter of the remaining sum. The third, a boy, £1 and one-quarter of the remaining sum, and the youngest, a girl, £1 and one-quarter of the remainder. The residue was to be given to charity.

When her will was read, the lawyer said, "She has left the two boys exactly £100 more than the two girls." Can you find out how much went to charity?

Solution.—The shares of the four children were £256, £192, £144 *and* £108. *The total of her will was* £1,021 *and the residue to charity was* £321.

A CATCH

Ask anyone this series of simple questions:

If I buy fifty cigars for fifty shillings, how much are they each? Back comes the answer without hesitation—one shilling.

If I buy 100 for 50 shillings, how much are they each? Again, without hesitation comes the answer—sixpence.

And finally, if I buy 75 cigars for 50 shillings, how much are they each? Back comes the answer—ninepence. And it is wrong.

It is amazing how everyone answers ninepence without hesitation, whereas the simplest calculation shows that it is eightpence. A case of jumping to the obvious conclusion.

WANTED, A GALLON

If you had three tanks with a capacity of 8 gallons, 5 gallons and 3 gallons respectively, labelled A, B and C, and they contained, A 5 gallons, B 3 gallons, C 2 gallons, how would you obtained a measured gallon in two moves? Quite simple, really!

You would transfer 1 gallon from tank A into tank C, thus filling the 3 gallon tank. This would leave 4 gallons in tank A, 3 gallons in tank B, and 3 in tank C. Then transfer 2 gallons from C into B to fill the 5 gallon tank, thus leaving 1 gallon in tank C.

DIVIDING A WATCH

Look at the face of your watch and if it has Roman numerals —I, II, III, IV, etc., and not 1, 2, 3, 4, etc.—you can do two pretty problems. The first is quite straightforward.

1. Draw two straight lines dividing the watch face into three parts so that the total of the numbers contained in each part is equal.

2. This has a catch in it. Draw three lines—they need not be straight—so as to divide the watch face into four parts, the numbers in each of which add up to the same total.

Solutions—1. *The lines run from between X and XI to between II and III, and from between VIII and IX to between V and IV, giving 26 in each section.*

2. *The three lines are as follows:*

From between I and II to between VI and VII.

From between XI and XII to the centre, then out to between VII and VIII.

From between X and XI, turn before reaching the centre and come in between the I and the X of IX—that is the catch—IX is divided into X and I, giving a total of 20 in each section.

YOUR AGE AND YOUR COINS

Tell me your age and I will tell you the number of coins in your pocket! It sounds impossible, but here is how it is

done. Write down your age. Double it. Add five and multiply the result by fifty. Subtract from this the number of days in the year—forgetting leap year. To this add the number of coins in your pocket. Then finally add 115.

Of the result, the first two figures will be your age and the last two the number of coins in your pocket—even when it is 00! It sounds crazy—but it works.

HOW MANY FOLDS COULD YOU MAKE?

Here is a safe bet. Offer anyone a pound for every fold they can make over twenty with a piece of paper. You can start them off with a sheet of newspaper. Fold it in two—that is one fold. Then fold it again—that is two folds (four thicknesses), and so you go on. Perhaps this bet looks risky to you.

Here are the facts. A piece of paper 1-1000th inch thick will after 10 folds be just over 1 inch thick (and quite unmanageable). At 20 folds where your bet starts it would be, if anyone could have folded it—just over 87 feet thick. A mere 39 folds would be required to make it equal to the diameter of the earth and 44 folds would make it equal to the distance from the earth to the moon! The easiest way to reach the sun would be to fold the paper 53 times, which would make it 93,000,000 miles thick. Incidentally, to have the smallest chance of being folded the sheet of paper would require an area of 2½ million square miles!

AND TWO MORE

No doubt you will have heard the monkey one. A monkey climbs a rope which passes over a frictionless pulley to a weight equal to that of the monkey. What happens? Do the weight and the monkey both reach the top at the same time?

Here is another for you to solve. A convoy a mile long is travelling along the road and at the rear a motor cyclist starts to drive to the front wagon. When he reaches the leading car he turns round and rides back until he reaches the last unit of the convoy. How far has he travelled?

THE JEWELLED CROSS

Here is a trick easily shown if you have a piece of paper and a pencil. First draw a cross on your paper, made up of small ovals. In the upright part of the cross there must be nine ovals, each representing a precious stone. In the cross-piece there must be seven stones, the middle one of which, of course, is the fourth stone down of the upright bar.

Now comes the story. The cross represents a brooch taken by a lady to a jeweller to be repaired. Each little oval is a ruby, and the lady wanted to make sure that none of the stones were stolen. So she counted them in several ways. Starting at the bottom she counted towards the cross-piece, then turned left along the arm. In this way she counted nine stones. Then she started from the bottom and counted towards the right, and again made the number of stones nine.

In spite of all this, however, the jeweller managed to steal two of the stones, and when the lady got the cross back she counted the stones again in exactly the same way and found she still had nine, counting from the bottom as before.

The jeweller deceived her in this way: He took away one stone from each end of the cross-piece and then moved the whole cross-piece one stone upwards. If you do this on your piece of paper and then count the stones as before from the bottom upwards to right and to left, you will find that the number of stones is still exactly what it was before, i.e. nine.

§IV

ABOUT OURSELVES

THE BODY'S RADIATOR

One of the wonders of the body is the way in which it ensures that the proportion of water to solid molecules in the blood remains the same. The sweat glands cannot, like the kidneys, return to the body any of the liquid they filter. Their job is to keep the temperature of the body constant, which they do by producing moisture the evaporation of which reduces the temperature. Incidentally, if the surface of the body gets too cold, the blood vessels contract ("goose flesh") and if the cold continues, you shiver, the muscles thus producing heat by work.

Hair "stands on end" as the result of the bristling action of almost atrophied muscles which used to work well on our animal ancestors.

Sweat is remarkable. A man working in a copper furnace has been estimated to sweat 600 gallons a year! To make up for this he has to drink between two and three gallons every twelve-hour shift! The sweat contains salt, and consequently men who sweat a great deal lose considerable amounts of salt. The result of this is to make them thirsty, which means they drink more water and make the blood more watery. This may result in violent cramps. The remedy is to drink slightly salted water, which is retained. Tennis players subject to cramps have found salted water a remedy. Miners and others engaged in work which means sweating a great deal may not know science, but their instinct seems to give them a taste for bloaters and other salty foods to replace the salt lost from their body.

THE COLOUR OF CLOTHES

The colour of clothes is important in keeping cool or warm.

This is because light colours reflect heat, while dark colours absorb it. Our clothes do not keep us very warm—it is the little particles of air imprisoned by the wool or other fibres that keep in the bodily heat or keep out the heat of the sun. Air is a poor conductor of heat—although it is quite a good conveyer of it in currents—and the billions of little "bubbles" of imprisoned air act as an insulating layer. Incidentally, it is this imprisoned air in the fibres of kapok that make it so springy for stuffing cushions or mattresses and enables it to support forty times its own weight in water, thus being ideal lifebelt material. It is also marvellously warm.

The colour of clothes is important in another way. The eye is apt to be more greatly impressed by light objects than dark ones because more light is reflected from them. Consequently, the same person often looks bigger in white clothes than in dark ones. (Haven't you ever noticed that Goering looks specially fat when he puts on that favourite white uniform of his?) This is very awkward for fat people in the tropics. They have the alternative of dressing in white, keeping cool and looking even fatter, or dressing in black, looking slimmer and being extremely hot!

THE MODERN "GOLDEN FLEECE"

A HUNDRED years ago you could tell more or less how rich a man was by his clothes. But that is no longer true for, although there are still expensive clothes and cheap clothes, science has made it possible for the labourer to dress as well as his employer. Artificial silk is the most modern of dress materials, wool is the oldest. After all, skins which cavemen used were simply wool held together by the skin. Machinery now has brought good clothes within reach of all, and the world's consumption of wool is about 2,000,000 tons a year. Mechanical clippers that shear the fleece from specially bred sheep mark the first stage in wool manufacture. Then comes washing and re-arranging the fibres. Spinning into threads is the next stage before mechanical brushing to bring up the

"nap", and the cloth has then to be shrunk before leaving the factory. From the time the fleece is removed from the sheep until it appears as a length of worsted it is dealt with entirely by machinery. Artificial silk is often made from wood; it is squirted through holes into threads.

BREATHING

Without breath there is no life, but few people realise the remarkable mechanism that constantly renews the oxygen in the blood cells so that it reaches every part of the body. Although the lungs are only a few inches wide and thick, the total surface of each lung available for taking up oxygen has been estimated at 1,000 square feet, or the area of a very large room! Every minute the lungs are filled and emptied eighteen times, much oftener if violent exercise is being done.

It would be wrong to suppose that all the air in the lungs is changed with every breath. With a normal breath of 300 to 500 c.c. as much as 150 c.c. may not get to the lungs at all. The lungs have a huge reservoir of air which is only changed slowly. If a very deep expiration is made after a very deep inspiration, a great deal of this air is blown out and a breath instead of being 300 to 500 c.c. may be more than 2000 c.c. When a large number of airmen were tested, they were able to expire between 2800 and 5000 c.c., or eleven times the normal breath.

People are apt to say that when we breathe in, the oxygen is absorbed from the air and the carbon dioxide breathed out. But expired air is by no means only carbon dioxide; indeed, only a very small percentage of it is. This percentage—about 5 per cent—is, nevertheless, large compared with the amount in the atmosphere. There is considerable oxygen in expired air—about 14 per cent, compared with 21 per cent, in inspired air.

As an oxygen extractor the lung is not very efficient. The rest of the breath is made up of nitrogen, although expired air has about six times as much moisture in it as inspired

air. It is this moisture, usually warm, rather than the carbon dioxide, that produces a "thick" atmosphere in a badly ventilated room full of people. We must remember, too, that a certain amount of breathing is carried on through the skin.

Some animals have interesting ways of breathing. The frog breathes by opening and shutting its nose—it breathes in through its mouth and out through its nose. Birds have air passages not only in their lungs proper but also through their bones.

The reason you breathe faster when working is, of course, that more oxygen is required as fuel. A person may breathe less than 8 litres of air a minute when resting in bed. Even the effort of standing increases the need to 10½ litres. Ordinary strolling calls for 18½ litres, while really fast marching at 4½ m.p.h. raises the need to 46½ litres.

You do not have to make yourself breathe faster. The regulation is in accordance with your needs. If you breathe faster deliberately when sitting still, you find you can only take shallow breaths afterwards. The action is partly nervous and partly chemical. The cells working in the body produce carbon dioxide and make the blood slightly acid. This sends a message to the brain, which orders faster breathing. Thus, to treat a man in danger of death through lack of breathing power, carbon dioxide and not oxygen is administered—the carbon dioxide makes his brain give the message to start breathing. This is remarkable when you remember that carbon dioxide in concentration is one of the gases feared by the miner!

When you travel to a considerable height and the oxygen is scarcer, you would think that you would automatically breathe faster, but you do not. This is because the carbon dioxide is also scarcer. The body can, however, become slowly accustomed to smaller degrees of oxygen. If you went up to a height of 14,000 feet, you would be exhausted after walking a few yards. But thousands of people live at this height and appear to suffer no inconvenience or ill effects.

An interesting application of the fact that carbon dioxide regulates the breathing is a cure for hiccoughs. This is simply to breathe into a paper bag. The percentage of carbon dioxide in the bag rises and is taken in in subsequent breaths and the hiccoughs cease. Possibly this is due as much to the power of suggestion as to the carbon dioxide.

SOME FACTS ABOUT SLEEP

We spend one-third of our lives—more or less—asleep, but no one knows why we go to sleep! We go to sleep because we are tired, it may be argued. But think the matter out and you will see it is not altogether correct. If we are physically tired, we can recuperate by rest—but it is not the same thing as sleep. If we are mentally tired, we may sleep; but if we are interested in what we are doing, or driven by necessity, we do not feel sleepy. An interesting game of cards keeps you wide awake far into the night, whereas a quiet evening at home may have you yawning in your chair before your normal bedtime.

Incidentally, yawning is not one of the first symptoms of sleep and not as rude as people suppose. We yawn to try and keep awake by taking a good lungful of air. If you are yawning when a friend is telling a story, it is not so much that he makes you yawn, as that you yawn to try to summon up energy to listen—so he ought to feel complimented rather than insulted!

The human body cannot do without sleep. A man is killed quicker by complete lack of sleep than by complete lack of food. Even a small deprivation of sleep quickly shows itself. In large scale experiments conducted with students, it was conclusively shown that when they had missed one or two hours' sleep, their brains were less alert. The loss was made up after one day—the human body soon feels the lack of sleep, but has remarkable powers of recovering the loss by additional sleep later. The British habit of getting up late on Sundays has something to recommend it.

Sleep is largely a matter of habit. Science has not been able to find the "right" amount—no more than is absolutely necessary for complete recovery and physical and mental alertness. Some great men like Edison, Napoleon and—it is said—Mr. Winston Churchill, are believed by some to have the remarkable gift of being able to manage with only three or four hours' sleep at night. It may be that because the first three hours' sleep is the soundest and most beneficial—a scientific fact—they do not miss as much as we might suppose. One man working on this theory had the curious habit of going to bed at nine, rising at twelve and working until three and then sleeping again until six. He claimed that in this way he got two three-hour "best periods". Perhaps this is borne out by the custom of short watches and guards in the services. Certainly men can do without eight hours' sleep in a comfortable bed for long periods without loss of efficiency.

Light and noise are great sleep disturbers, and sleep that is disturbed—even if the sleeper does not wake—is less beneficial; that is, it takes longer sleep to have the same effect. But a dog-tired man can sleep soundly through anything and anywhere—even standing up.

Rhythm undoubtedly plays a part in sleep. That is probably why there is a tendency for drivers at night to fall asleep at the wheel, and it explains, even, why men may feel they want to sleep on the march. Many freak "cures" for insomnia have been based on the principle of producing a sleep rhythm.

It is an old saying that it is good to "sleep on it". There is science behind this saying. In sleep, the barrier between conscious and subconscious mind is lowered—hence the strange dreams we get. The subconscious mind may have arrived at a solution of a difficult problem but be unable to present it to the conscious. Sleep lowers the barrier and the problem is presented, often, apparently at the moment of waking-up. That is why you should always sleep on a

"strong" letter. The probability is that next morning you will be very glad you never posted it.

This explains also inspirations and inventions that occur in dreams. It is not that some supernatural force is at work, but simply that the powerful subconscious is allowed to present results it has worked out or facts it has noted. Quite a number of inventions and discoveries have been made as a result of dreams and dreams have also been the inspiration of great poems. In dreams we can pass a lifetime in a few seconds.

Have you ever thought you were hunting a lion and on waking up, as the gun fired, you have found that the bang was someone tapping on your bedroom door?

For the tap on the door to seem the bang of the gun means that the whole long story of the lion-hunt has taken place between the time of the tap on the door and your waking.

Does it also imply, if the two bangs synchronise, that you have constructed the story backwards?

IS IT HUMILIATING?

Do you realise that we are all very savage? We still chew meat with our dog teeth; we have not yet lost the remnants of fur which used to cover our bodies; and our throats still bear an unmistakable likeness to those of fish.

Civilisation has dulled many of our senses, if it has improved others. Our eyes and ears are less keen than those of many animals, although human beings possess the best average collection of senses of all living creatures. Many of our physical attributes require help. Teeth, eyes and ears are all examples. Even walking is becoming less necessary.

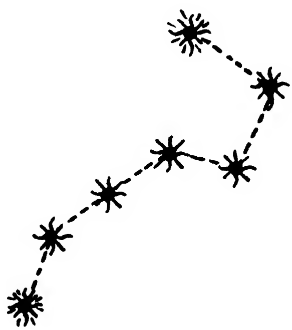
Perhaps we shall become thinking machines in the far future, or in days to come when we attempt to reach other planets. Quite serious attempts have been made to design "rocket ships" for this purpose. Propellers would be no use when passing through the upper stratosphere where there is no atmosphere.

§V

DO YOU KNOW——?

HOW TO FIND YOUR WAY BY THE STARS

On any clear night the constellation known as the Great Bear, or the "Dipper", can be seen; perhaps the easiest group of stars to identify. There are seven stars in the group and they form, roughly, the outline of a dipper or soup ladle with a curved handle. Four of the stars form the bowl, two at the top, two nearer together at the bottom.



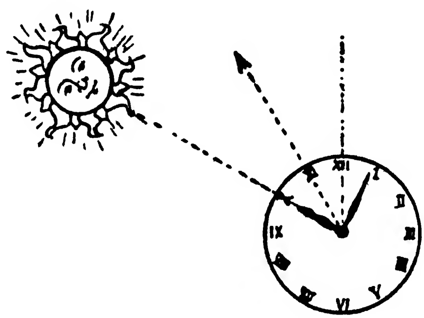
Fix your eyes on the two stars that form the outlet of the bowl, from the bottom to the top. Imagine a straight line connecting the two stars and extend it upward in the same direction until it runs into another bright star. This is the Pole Star, and indicates the north. When you face this star you are facing due north with sufficient accuracy to make finding your way possible.

This star does not move appreciably during the night—it is the star nearest to directly overhead at the North Pole. The Pole Star is 465 light-years away and is 2,500 times as brilliant as our sun.

FINDING YOUR WAY BY YOUR WATCH

Point the hour hand of the watch at the sun. Note the angle the hour hand makes with the figure XII and divide it in two. The line dividing the angle will point due south. For instance, if the hour hand points to VIII, then a line from the centre of the watch to X will give you south and III will give you north.

If you stand facing the sun your direction is east about sunrise, south-east in the middle of the morning, south at noon, south-west in the middle of the afternoon, and west in the evening. These directions are only approximate.



SUN

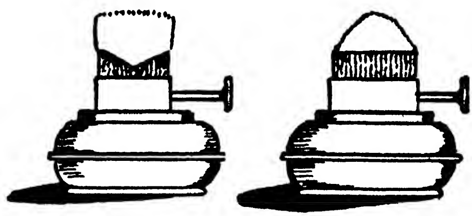
In the above diagram the angle of the hour hand with the figure 12 *is* 45 *degrees.*

JUDGING DISTANCES

At fifty yards you can see a man's eyes clearly;
At a hundred yards, the eyes are only dots;
At 300 yards his face is indistinct—simply a blob;
At 400 yards his legs can be seen moving;
At 500 yards his head can be seen;
At 700 yards the head can only be seen with difficulty.

It must be remembered that this is only a rough guide

and conditions of visibility may alter the observations considerably. Distance is often overestimated in a dull light, or when the object and background are of the same colour. It is underestimated when the sun is showing up the object brightly, when looking across water or when looking up or down hill.



(1) (2)

HOW TO CUT A WICK

A lamp wick, cut as in Fig. 1, *will always burn well and steadily and without smoke. No.* 2, *after a few hours, begins to burn unevenly and to smoke.*

TAKE CARE OF YOUR FEET

INFANTRY are still foot soldiers, even when motor vehicles play an important part in their transport. Your feet are, therefore, your best friends. It is curious but true that many men who would lavish great care on their motor cycles expect their feet to look after themselves. Look after your feet and they will serve you well.

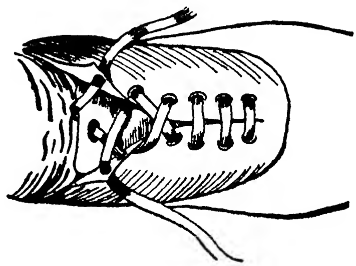
The two great causes of foot troubles of all kinds are dirt and badly fitting boots or shoes. Your feet should get a wash every time there is an opportunity. If a wash is impossible, the next best thing is a wipe-over with a wet cloth. Do not neglect the parts between the toes.

Well-fitting socks are as important as well-fitting boots. Socks that are too tight can cause very sore feet. The socks should always be stretched when taken off, and it is an

advantage to change them from one foot to the other.

If feet are apt to sweat excessively, it is sometimes helpful to bathe them in water in which a few crystals of permanganate of potash have been dropped. A light dusting of boracic powder is helpful—any powder is soothing.

Soreness or tenderness at specific positions can be helped by vaseline inside the sock; but if any place is cut, or rubbed raw, it should be treated with the greatest respect and special care taken to keep the part clean.

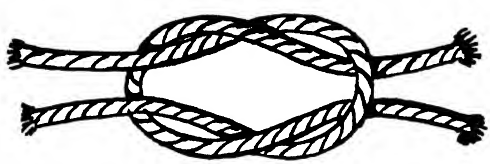


KEEPS TONGUE IN PLACE WHILE MARCHING, ETC.

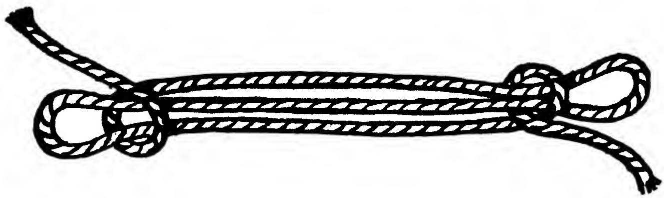
End of lace passed through top of tongue as shown prevents tongue of shoe doubling itself up and so creating acute discomfort.

REEF KNOT

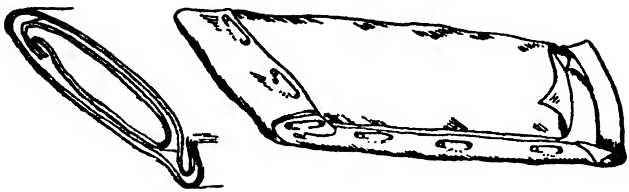
Very useful for First Aid, as it stays flat and can be easily undone. It is always used for an arm sling, but is altogether the best knot for all surgical dressings, etc.



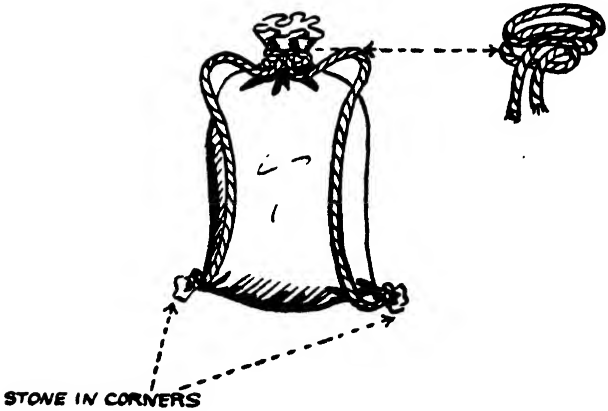
A good knot specially useful for shortening a rope which has its two ends fixed.



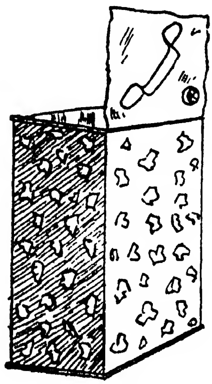
The best and warmest method of folding and pinning 2 blankets while in camp.



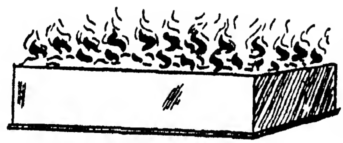
How to make an ordinary sack into an improvised rucksack.



A fruit tin or cocoa tin stuffed with rags soaked in oil makes a good improvised lamp which will burn for an appreciable time.



A good brazier can be made from old petrol cans as sketch. They burn well and supply good heat, both for warmth and cooking.



A flat biscuit tin containing some rag embedded in melted candle ends makes a splendid improvised stove for frying bacon, eggs, etc., when no other form of fire is obtainable.

KEEP YOUR RAZOR REALLY SHARP

You may think your razor has a fine smooth blade, but if you could look at it under a microscope you would see that the edge is actually saw-like. If this edge is oiled after use it will help to preserve it for a long time; just a touch of the finger on your well-brushed hair will often leave enough oil to put along the sides of the razor blade near the edge in order to form a protective film of oil.

WHY THE SKY IS BLUE

We are apt to think of the sky as a great circular dome of something blue. Actually, of course, there is "nothing there". The circular appearance is due to the shape of the earth, a section of which must be circular. The blueness is due to the refraction or splitting up of the sunlight by innumerable particles of dust and moisture in the atmosphere. If there were no dust in the air the sky would look inky black, with the stars hung in it like jewels. This, incidentally, is how the sky will appear to the first men to ascend well beyond the atmosphere—perhaps in a rocket-plane.

WHY STARS TWINKLE

Stars are not, of course, the many-pointed objects which artists draw—in fact they are anything but star-shaped! The tremendous forces and speeds of the heavens call for everything being round and travelling in curves, and this is clearly shown in photographs.

The many-pointed appearance or twinkling of the stars is due to the unsteadiness of the earth's atmosphere arising from unequal heating of the air as well as to physiological causes. The twinkling is caused by the air and not by the star. The light is unequally refracted and gives a distorted appearance to its source—the same effect is produced if a candle is looked at through agitated water.

This unsteadiness, by the way, is a great handicap to the astronomer who, at the best of times, has to be constantly adjusting his telescope as the star appears to move.

Incidentally, the refraction of the earth's atmosphere bends the light from the sun and the moon, with one curious result. When they have actually disappeared below the horizon we can still see them, apparently just above its line.

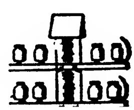
WHY WE CAN'T FLY

The very first attempt of men to fly were made with moving wings which they flapped up and down. These attempts were

a failure, and it was not until man abandoned the flapping wing that he made progress with aviation. Yet the idea has never been entirely abandoned and there are still enthusiastic inventors who produce wings—ornithopters, the machines are called.

Their attempts are doomed to failure for reasons which can be simply demonstrated. One of them is the comparative puniness of men's muscles. The wing muscles of a bird, in comparison to a man's, are of tremendous strength and take up a considerable amount of its weight. The bird has specialised in muscle. Even if men tried to grow these great muscles, they would not achieve their object because their weight would also increase.

Man's size is against him. The smaller an object the greater its superficial area compared with its weight. A germ is heavier than air; but because its surface is, compared with a man's surface, thousands of times greater than its weight, it can support itself. A mouse can fall many feet and land unhurt, but a man falling a few feet is almost bound to break a bone. It is not an accident that the biggest birds cannot really fly well and that there is no bird as large as an elephant. The largest mammal can only live in the sea—the water supports the great weight of the whale, which would require legs many feet in diameter to support it on land.



The cross-bars on a telegraph pole are always attached to the side nearest London.

* * *

Do YOU know that aeroplanes fly like kites? The string is replaced by the airscrew. It is usually more correct to say that they are supported by a vacuum over the wings rather than by pressure underneath. It is really something of both these effects.

WHY WE USE "STREAMLINE"

MOST people know that if your car is streamlined it will move faster on the same driving power than another which is without streamline. The reason for this is that wherever you have any sort of projection on your car it makes a disturbance of the air. Thus the important thing is "lack of projections". Everything should be well rounded off to give as little resistance as possible to the air. Nowadays we have found that it is not necessarily the sharpest-pointed vehicle which gives the best effect. Most well streamlined cars are now blunt-nosed affairs. This does not quite resemble the girl-friend whom, as a rule, we consider so well-streamlined. Perhaps the comparison, after all, is not so absurd as it sounds. The girl usually moves along quickly, gracefully, and swiftly and without meeting any resistance.

DO YOU KNOW WHERE MONEY GOES?

WE ALL know how slowly money comes to us and how swiftly it seems to go. But do we all realise how much work, say, a ten-shilling note can do in a short space of time? Here is possibly a day's history of one such note.

Tom Smith goes into the Crab and Lobster and, after a pint or two, finds by the time he has paid for his drinks that he has nothing left. As the publican is a friend of Tom's he manages to borrow a ten-bob note. Alas, as he goes out, Alf Jones taps him on the shoulder and reminds him that he owes him—Alf—ten bob. Tom gives him the note with a muttered curse. Alf, meanwhile, goes into the street and later on meets his bookie to whom he gives the note in settlement of last week's account. Half an hour later the bookie, who has had a good week, stands a round of drinks to his clients at the

Crab and Lobster and pays with the ten-bob note. The publican puts it in his pocket without realising it is the same note he parted with an hour ago, which has, in the meantime, settled half a dozen people's debts.

WHAT TO DO FOR SNAKE-BITE

Tie a handkerchief round the limb between the wound and the heart. Place a short stick in the loop of the bandage and give it a good twist till you have stopped the flow of blood. Then suck the wound, if you can. If you have a clean sharp knife make the wound a little larger so that it will bleed quite freely. Give the patient plenty of whisky or brandy, or sal volatile, anything to quicken the heart-beats. If you have it, also apply strong carbolic acid or permanganate of potash.

The adder is Britain's only poisonous snake. As both male and female vary considerably in colour, from red-brown to grey or olive, it is best for the amateur to rely on the shape of the head as a means of identification. The wavy, dark zigzag lines down the centre of the back may be accompanied by dark spots. On the head, which is broader than that of any other British snake, are distinct V markings. The adder is a thicker and shorter snake than the familiar grass snake.

WHISKY AND MILK

The old Celtic word "usquebaugh", meaning "Water of Life", is the origin of the word "whisky"—a more endearing description than that given by the dictionary, which bluntly terms it "an alcoholic liquor distilled from cereal grains".

Whisky distilling became widely popular in Europe during the 16th and 17th centuries and has, as you probably know, remained so up to the present day. Whilst in Southern grape-producing countries wine is the usual drink, various types of grain are used in the Northern countries of Europe.

The process of manufacture of whisky may be divided into three stages: the mashing of the grain, or preparation of the liquor known as "wort"; the fermentation of the wort to

produce the "wash"; and the separation of the spirit from the wash by distilling.

In spite of the popularity of whisky, however, its consumption has steadily declined during the last few years. This is probably due to the change in popular taste and habits as well as to the increase in price. Statistics tell us that in 1935 consumption per head in Great Britain was one-sixth less than that in 1900.

Milk, on the other hand, appears to be fast gaining in favour—and it may well be that, within a few years, the cow will be the most popular of all distilleries.

ROLL OUT THE BARREL!

WHEN you see a fine field of golden barley it may suggest to you, especially on a hot summer day, that a cool glass of beer would be welcome, and as long ago as 3000 B.C. beer was brewed from barley or other cereals; which shows that the ancients, as well as ourselves, were fond of the nutbrown ale!

Three ingredients are used in beer brewing: malt, hops and water, and the chief points of the process are malting, mashing, boiling of the wort, refrigerating and fermentation. First the barley is malted, which is the artificial germination which renders it suitable for brewing; then it is mashed with hot water, the insoluble matter being removed; the wort or sweet liquor obtained by mashing is then boiled with the hops; this mixture is cooled, and finally fermented by the addition of yeast, before being run off into casks which will take it out into the world.

It is interesting to note that so easy was the production of beer that in the 16th and 17th centuries almost every housewife of standing brewed beer because of the scarcity of pure drinking water, but after that time the practice passed almost entirely into the hands of public brewers.

Men are not the only beer-drinkers, for probably the greatest are elephants, who will consume it by the bucketful until they become hopelessly intoxicated.

It is a strange fact that alcohol and the basic material of silk stockings can both be used for making explosives.

WHAT IS MARGARINE?

MARGARINE was the invention of Mege-Mouries, a French scientist, who was working in response to the urgent call of Napoleon III to find a substitute for butter. What, in fact, Mege-Mouries did was to "short circuit" the cow. The cow makes milk, from which we make butter from its own fat. The scientist takes fat and turns it direct into margarine. The name comes from the Greek word for a pearl, for the millions of little globules of fat formed in the process of manufacture reminded the inventor of pearls. Mege-Mouries patented his process in 1874, but in Great Britain it was not manufactured in quantities until the last war.

As food, margarine is said to be as good as butter. The one element missing—the valuable vitamins A and D of butter—can now be added artificially. These vitamins are called "sunshine vitamins", for they are formed by the action of sunlight. The scientist now subjects the margarine to artificial sunshine, or "irradiates" it, and gives it vitamin value, which is claimed to be equal to that of the best summer butter.

WHAT IS TOBACCO?

TOBACCO is the prepared leaves of certain plants of the genus Nicotiana. Its effects are said to be due to the presence of an alkaloid called nicotine, but since one drop of this is sufficient to kill a man, it is clear that only a very trifling amount from each cigarette is absorbed into the system. Nicotine is not the sole attraction of tobacco, otherwise we could make a good substitute by soaking brown paper in pure nicotine! Pyridine, tars, and other chemicals add to the appeal of smoking to nose and palate—much the same thing!

The habit of smoking was introduced into England about 1586 on the return of Drake from Virginia. Tobacco will grow

in many different climates, from tropical to north temperate, but various regions are specially suitable for growing certain types of tobacco. The leaf is green until harvested and dried. It does not get its characteristic colour or flavour until cured, fermented and aged.

There are three main methods of drying and curing. Sun-dried tobacco results in a sweet chewing tobacco. Cigar tobaccos are usually air-dried in barns. A third method is by artificial heating. Open fires give tobacco a smoky odour; flue-cured tobaccos are bright yellow.

The dried leaf is very brittle; it is left hanging until it absorbs moisture and is safe to handle. The leaves are then stripped from the stem, sorted and fermented by piling them in sacks. Tobacco may be aged in warehouses for four or five years. It may be flavoured with sugar, liquorice, spice or alcohol.

Cigarettes, except those you roll yourself, are now generally made by machines able to turn out many thousands an hour. The machines are very ingenious, being based on careful timing of cogs, cams, levers and other mechanical devices, each performing with great precision. The paper is fed to the machine as a long tape, the name of the maker or brand of cigarette printed on at the correct intervals, the finely shredded tobacco fed on to the strip, a continuous cigarette being formed and sealed. This is sliced off at the correct lengths and the cigarettes automatically counted out in tens or twenties. Even a large part of the packing and sealing is performed by machinery.

HOW TIME IS MEASURED

If you want to know the time you look at a watch or a clock. But clocks do not measure time—they only record its passage, just as a ruler does not really tell you how long a yard is. A yard ruler is a copy of a copy of a standard yard of great accuracy which is kept under lock and key. What does a clock copy? The standard used for time is the period taken

for the earth to complete one revolution on its axis. Clocks divide this period into twenty-four parts, and each twenty-fourth into 60 minutes.

Actually, this standard rotation is imaginary, for the astronomer corrects it so that we have a day of perfectly equal length all the year round. He measures the passage of time by observing a star passing a fixed point in his telescope and counting the period that elapses before it passes again. The star appears to move across the cross-pieces of his telescope. Of course, the star is really "fixed" and it is the earth that moves.

Observations are made at Greenwich and Edinburgh, the results being used to correct the master clocks. The average of several observations is made with great accuracy, the passage of the star being recorded electrically by a micrometer device. The average of these observations is then compared with the average time recorded by a number of clocks and a correction obtained, "right", perhaps, to 1-100th of a second. It is as a result of all this trouble that we get the pips from Greenwich on the wireless—the standard by which the whole world sets its clocks.

We cannot use the sun to tell our time with accuracy because of its varying position. Sundials have to be adjusted to latitude and even then can only be correct on four days a year. At other times they are fast or slow by an appreciable amount, quite apart from "Summer Time".

The world is divided into a number of time zones, in each of which clocks are so many hours fast or slow of Greenwich. Travelling westward you put the clock back, travelling east you put it forward. The fast and slow zones meet on the international date line, where a whole day has to be added or subtracted, according to which direction you are travelling. For convenience, this imaginary line in the Pacific avoids all land—the people living on it would find that time stood still!

The zones are necessary for convenience in a civilised

world, and all clocks are set to the same time, regardless of the moment of sunrise or sunset. In Britain this may vary with latitude and longitude by as much as half an hour. If the U.S.A. were not divided into four time zones, the citizens of San Francisco would find themselves going to bed in broad daylight in the middle of winter—it would be 6 p.m. in San Francisco (by the sun) when it was 10 p.m. in New York. This explains, also, why we in Britain can get Australian cricket scores for the same day at 9 a.m.

Since the earth is roughly 24,000 miles round at the equator, any given spot travels at about 1000 miles an hour. Thus when our aeroplanes are able to travel at this speed we shall, as it were, be able to keep pace with time. We could travel round the world and make sure that whatever time we arrived the "pubs" were always open! We could enjoy 24 hours' sunshine every day all the year round!

That this is not a matter of entirely theoretical interest is shown by the fact that when the Germans fired "big Bertha" in the Great War—a distance of 75 miles—they had to allow for the amount the earth would rotate during the period the shell was in flight.

The fastest planes fly at about 500 m.p.h. The speed of the world's record car is 363 m.p.h., so that if you stepped off the kerb at the Albert Hall, just as the car left Marble Arch, you would be run over by it before you had crossed the road—unless the driver was very wary.

DID YOU KNOW THAT——

IF THERE are inhabitants of other stars who can see the earth, they would now be seeing chariot races that took place in Roman times, and not greyhounds or the Derby.

Do you know why a basin sometimes sings when filled with hot water? This is due to expansion of air and its escape from underneath the glazed surface of the china.

*

Sunlight does not "put out" a fire. It only makes the fire less visible. So don't blame the sun!

There is a spider that spins a web that looks like the droppings of a bird, then lies in the centre ready to catch the butterfly that feeds on birds' droppings.

When you drop a stone, the earth and the stone both move together.

To tell the speed of a train count the number of telegraph poles passed in one minute and multiply by two.

There is an African bird called the *Tufted Umbre* that builds a three-roomed flat, so that when the young hatch out they live first of all in a sleeping-room, then move down to a nursery, and finally visit the 'hall'.

* * *

To make a warm sleeping-bag out of a single blanket, fold it lengthways, stitch together or pin with safety pins the two outside edges and bottom. If desired the bottom of the blanket may be folded over when pinned to give additional warmth.

There are red rains, yellow rains, black rains and white rains. Science explains them as follows: Red rains are a mixture of rain and reddened mineral dust; yellow rains are rain mixed with sulphur from volcanic eruptions, or with pollen from pine trees; black rains get their colour from soot from forest fires, and white rains are a mixture of rain and chalky earth.

§VI

SCIENCE

MANY LITTLE THINGS

SCIENCE now pays more and more attention to little things. We have discovered that all materials are made of the same initial material. This seems to be something like electricity itself in some electronic form. These particles make up atoms, of which many millions could rest on a pin's head.

WE EVEN know nowadays that light has weight. A 10-horse-power searchlight discharges one-hundredth of an ounce of light per century and the sun 360,000,000,000 tons in a day. Waves in the ether correspond to the keyboard of a piano in some respects. There are long wireless waves of 30,000 metres; medium waves; Hertzian waves which are very short radio waves; and so on right up to light with wavelengths of about .0006 millimetres, and X-rays of .000001 millimetres, with heat or infra-red coming in between. Light actually presses on you . . . but not very hard!

IT IS difficult to say when anything stops in this world. It never is really finished, like a bell which "stops" ringing. What we mean is that we cannot hear it; although with an amplifier we could probably detect it quite easily. If you drop a tea-cup in London the "bump" is felt in Australia. But it is so small that it is negligible to our senses and only true in a certain mathematical sense.

A TOUR ROUND THE SUN

LIGHT from the sun, shooting outwards in all directions, first of all meets the planet Mercury, 36,000,000 miles away. There may be a planet inside the orbit of Mercury, but the

intense light makes observation difficult and so far no positive signs of it have been found.

Next, the light strikes Venus, 67,000,000 miles from the sun. On the way it may meet one of the numerous minor planets or asteroids, bodies only a few miles in diameter but otherwise like miniature planets. They are, of course, completely without atmosphere. Their small size makes their gravity so low that they have been unable to hold any gases that may have formed on their surface.

The Earth is next, 93,000,000 miles from the sun; and, passing on another 48,000,000 miles in a matter of four minutes or so, light reaches Mars. Then there is a very long journey before it arrives at Jupiter, 483,000,000 miles from its starting point. On again, almost double the distance it has already travelled, and 886,000,000 miles from the sun is Saturn. Another journey, almost double the length of that already made, and there is Uranus, 1,783,000,000 miles from the sun. On the outer edge is Neptune 2,793,000,000 miles from the sun; and beyond this even, Pluto—the last discovered planet.

It is awe-inspiring to think that this is only *our* solar system, that there are millions of suns, many much brighter than ours, and that when we speak of the Universe we mean only *our* universe. Beyond this are countless other universes.

With the naked eye it is possible at different times and in different places to see about 10,000 stars. It is never possible to see them all at once—two or three thousand is about the limit. A small telescope makes another 20,000 stars visible. The largest telescopes make perhaps a thousand million stars visible—no one has had time to count them, but their number can be estimated on the same principle that you do not have to count every grain of sand on the seashore to know the number in each cubic yard. Beyond the range of the most powerful telescope are probably billions of other stars.

Yet the extent of space is such that there is no overcrowding. Travelling at the speed of light—the fastest thing

we know—you could tour for years, even centuries, without reaching a star! You would travel 5,860,000,000,000 miles a year. *Astronomers estimate that to travel across the entire* universe you would, even at this tremendous speed, require 6,000,000,000 years! This is longer, we believe, than it has taken the Earth to evolve from a fiery ball into a habitable and—moderately—comfortable place to live on!

ABOUT WATER

THE amount of water consumed by a nation is quite a good indication of their standard of living. It is the first "luxury" they demand. It is interesting to note that, per head, the modern citizen of Rome gets no more water than did the ancient Romans at the time of the Empire. In Britain we consume 25 gallons a day for every man, woman and child. Of course, water is used not only for drinking and washing, but also in huge quantities by industries.

The two great sources of water supply are wells and rivers. Well water is usually pure, but it may be contaminated by leakage from soil and rock in the upper layers. That is why wells are always carefully lined with brick or metal. River water is always more or less polluted and is treated by storage —which starves harmful growths and bacteria to death— sand filtering, or chemical treatment.

Hard water owes its property to dissolved compounds of calcium and magnesium. When soap is added, these form an insoluble compound—hence the thick scum formed when washing in hard water. After a time the soap precipitates all the hardening salts and a lather is formed, but this involves considerable waste of soap.

Some hardness is removed by boiling. Carbon dioxide is given off and an insoluble compound precipitated—this is the fur found in kettles in which hard water has been boiled. Water can be softened by adding lime and filtering, but it is not then suitable for drinking. Domestic softeners often contain sodium silicate. The hard water, trickling round this

chemical, forms calcium silicate and sodium carbonate. The latter, better known as soda, is soluble and passes on, leaving the calcium silicate behind. After a time all the sodium silicate is used up and has to be "regenerated". This is done by running salt water over it. Sodium silicate is formed again; the calcium chloride being soluble passes on and is thrown away.

EARTH'S HISTORY-BOOK

THE most fascinating book ever written is the story of the Earth, and if we can forget petty human measurements and remember that 10,000 years is a short time in a tale that is more than forty million years old we can read and wonder as we travel along.

Every rock and stone that you see as you walk has a story to tell. If you know the Isle of Wight you will remember that the cliffs are a dullish green with occasional streaks of colour. These are sandstone, made up of tiny grains of hardened sand. The green is caused by iron oxide. This sandstone is produced by piled-up masses of sand, and then sand is formed again when action of weathering breaks up the sandstone rocks. You may have picked up for yourself near some quarry a stone that bears strange ripple marks upon it. These were made by the sea upon the beach millions of years ago.

Limestone is another type of rock to be found in Britain. Limestone dissolves very easily when acted on by water, and in the Mendips and the Pennine hills there are wonderful caverns of this rock. If you pour a tiny drop of weak hydrochloric acid on to a piece of limestone it will "fizz" where the acid touches it. This is merely escaping carbonic acid gas. But if the stone is not limestone the acid will not affect it in this way.

Fire-formed rocks which are sent up boiling hot from the inside of the earth crust are usually known as volcanic and there is much of this type in the British Isles, especially in Scotland and Ireland. These rocks are dark and heavy, and

full of chemicals, making fine soil for plants. The islands of Skye and Mull are built on them. We find them in the Chevoit hills, in the Lake District and in Wales.

Granite is easily identified. The kerb that you stand on at the street corner is often made of this stone, and if you were to see a piece of it clear and not covered with dirt you would realise how beautiful it really is. This rock is made up of various grains, some bright, others dull and heavy. These are called feldspar, mica and quartz. Usually granite is grey; but there are other kinds in which red and brown tints are found. If you find a handsome grey stone with sparkling lights and here and there white crystals, that is Dartmoor granite. In London, outside St. Pancras station, there are some beautiful granite pillars of a brownish-red colour.

In reading earth's story in the rocks we might almost call the fossils that are so often found embedded in them, the "illustrations". If you use your eyes you will often find fossils in the places where rocks have been used for ordinary every-day affairs. In a marble slab in a restaurant you will frequently see fossil shells; in limestone buildings, bridges, marble counters and shop fronts. In a heap of gravel, if you turn it over, you may sometimes have the good fortune to discover a sea-urchin or sea-lily, and on the rocks at Bexhill are footprints of an iguanodon which roamed the earth in dinosaur days. So you see there is drama and adventure behind almost everything you come across.

HEAT AND COLD

When a liquid or a gas is heated, the heated particles flow upwards, producing convection currents, so that eventually the whole body becomes hot. You can see this quite easily if you drop a single crystal of potassium permanganate into a bowl of water which is being heated from below. The streaks of pink will show how the current flows up one side and then, as it cools, down the other to be heated again. If you apply heat to the top of a bowl of water it takes a very

long time to become hot, because the convection currents cannot flow and the heat must be transferred to the bottom by conduction. Water is a poor conductor.

This enables you to boil water in a test-tube containing a lump of ice without melting the ice! The ice has to be weighted to the bottom and then the heat applied to the water near the mouth. This water will boil before sufficient heat has been conducted away to melt the ice. For this reason, if you use an immersion electric heater it should be placed as deeply as possible.

Now of course the contrary is equally true, and cold flows downwards. If you wanted to cool a room with a lump of ice the best place to put it would be near the ceiling. To cool drinks most people stand them on ice. This is ridiculous. The jugs or bottles should be placed under the ice.

Have you ever kept the coffee or soup hot in a water bath? This is a device the chemist uses a great deal. The kitchen should be more familiar with it. In its simplest form it is a saucepan of water into which the coffee-pot is placed at an angle so that it does not touch the bottom. The water in the saucepan can be boiled, but however hard it boils, the coffee or soup will never boil. The explanation of this is latent heat: the coffee can reach boiling point—the same temperature as the water—but can never get the extra heat required to turn it into vapour.

If salt water were used in the saucepan, the coffee would boil, for the boiling point of salt water is higher than that of fresh water and it would, therefore, be able to transfer the necessary heat. This is useful to remember, for there are occasions when water at a temperature higher than boiling point is valuable. To boil eggs or potatoes on a mountain is difficult because the reduced pressure means that boiling point is well below the normal 212. But if the water is well salted the boiling point will almost reach normal.

The body is a remarkably poor instrument for measuring temperatures. Whether water, for instance, feels cold or hot

may depend on the temperature of the last thing you touched. If you have three bowls of water, one very hot, one lukewarm and one very cold, and place one hand in the hot and one in the cold and then both in the lukewarm, the water will feel hot to one hand and cold to the other!

Incidentally, soda water does not "fizz" at the bottom of a mine because the pressure of atmosphere keeps the gas in solution. It is risky to drink aerated water at a low level and then rise to a higher level too suddenly!

SAFETY FIRST WITH ELECTRICITY

Electricity is one of the great servants of Man. Yet it causes hundreds of deaths a year. We are apt to call these deaths "accidents", but they are often nothing of the kind. Many are due to ignorance of the simplest laws governing electricity, or to carelessness. The reason why science is so delightful a study compared with that of human beings is that there are no "accidents"—only things we do not understand. There is a great deal we do not understand about electricity, but we know enough to avoid nearly every accident by a little thought. The great thing is to make safety a habit. Then, even if you are in a hurry or are forgetful, you are not likely to make a fatal mistake.

Electricity will only travel in a "circuit" which is complete. The circuit may be completed by wires, as in the telephone and telegraph, but more often it is completed by "grounding" or "earthing". The earth is a vast reservoir of electricity—always ready to accept an electric current, big or small, and to complete a circuit.

This fact shows how easily people may be injured, even when they only make slight contact with a current, which makes the easiest path through their body to the earth. Electricity is always seeking the easiest path—not necessarily the shortest—and always chooses a good conductor in preference to one that is a poor. Water is generally a good conductor of electricity and makes an excellent electrical

contact. Therefore, avoid handling any electrical apparatus, even if it appears well insulated, with wet hands or feet—wet feet in the bathroom make an excellent contact with the earth and encourage any current to travel through the body. Metallic switches should not be touched with wet hands. Any flex that has been wet should be carefully examined—the moisture may provide an easy passage for a "short".

You cannot be hurt by an electric circuit that is not complete. Therefore, by removing a fuse from a circuit you can deal with it safely. It is like blowing-up a bridge to prevent the enemy crossing. Always remove fuses or turn off the main before repairing switches, etc. But fuses serve a purpose and should be kept in good order.

A plain fuse consists of a metal of low melting point. When the current for any reason rises above a certain point, the heat generated becomes sufficient to melt the fuse. The exact moment of melting is determined by the fuse and expressed as 5 amp., 10 amp., 15 amp., etc. The amperage should always be right. To place a piece of ordinary wire or a nail in a fuse is dangerous. The purpose of a fuse is to form the weakest link in a circuit so that it can burn in safety. If the fuse is not weak enough, the result of a fault may be the burning of valuable apparatus or shorting across the wires, causing a fire.

Accidents occur because people take risks. You may have inserted a new lamp in its holder without switching off a hundred times without accident. But the 101st time you get a shock. Only about one death in a thousand is caused by electrocution, but why should it be yours—unless you have committed murder in America?

Electrical pressure is measured in volts, the current in amperes. The product is "power" in watts. High tension electricity is essentially the same, only the pressure is very high and the current usually one of very low capacity.

Friction in a sandstorm will sometimes charge a car body and give slight shocks. Friction of a steam jet or of wind

against a balloon causes charges which sometimes have to be grounded to prevent danger.

Electric sparks are used for high-speed photography. The high speed camera, however, is usually worked by taking a large number of pictures at low speed and running them off at high speed.

When you rub your fountain pen it becomes charged and by inducing an equal and opposite charge can pick up a piece of paper.

If you dry a piece of brown paper thoroughly you can draw sparks from it after drawing it smartly under your arm. Hold it over your head and watch your hair stand on end.

PRESSURE AND WEIGHT

If you put your hand on a spring scale and press hard the scale shows your hand as weighing eight or ten pounds. And so it does! For weight is simply the pressure exercised by a body. The fraudulent shopkeeper who leans his elbow on the scales is not faking. He is simply weighing his elbow with the sweets or whatever it may be. He perpetrates his fraud when he fails to deliver the goods—or all the goods—he has weighed! A Shylock customer might insist on his "pound of flesh".

Weight is due to the fact that every body attracts every other. A scientist might find it difficult to calculate pyschologically how much you attract a girl—but not mechanically. All he wants is your weight and her weight and the distance between you. He knows that every pound of matter, whether it is chalk or cheese, attracts every other pound at a distance of one foot by 1/440,000th part of a grain.

Owing to the shape of the earth and the constitution of the matter underneath it, a pound is not the same weight in different places. Of course, it will show the same on the scales, because the same change takes place in the scales, but the fact remains that a pound of tea on the equator is not such a good bargain as a pound of tea in England.

This difference in weight—or gravity—can be measured by delicate instruments and is very useful. For one thing, it enables geologists to determine what is underneath the earth's surface.

Wind is usually measured by its velocity but we could equally well measure the wind by its weight, and this in fact is how wind measuring instruments work—the pressure of the wind is recorded: 10 m.p.h. equals nearly ½ lb. per square foot, 20 m.p.h. equals nearly 2 lb. per square foot; 45 m.p.h. equals 10 lb. per square foot; and 60 m.p.h. is 17¾ lb. per square foot. Engineers are able to estimate the force that a bridge or house may be called upon to withstand and design accordingly.

The pressure of wind is trifling compared with the pressure of water, because water is so much denser—the effect of a jet of water under pressure is much more devastating than a jet of air under the same pressure. The pressure (or weight) of water in the sea increases about 115 lb. for every 30 feet. The pressure at the deepest place in the ocean must be about 7 tons to the square inch.

An interesting point illustrating what this pressure means is that if we could lower a gun far enough into the sea and pull the trigger, it might not go off—even if we took care that it did not get wet. The reason is that the pressure outside the barrel would be greater than the pressure of the explosion inside. The barrel, incidentally, would not burst, because of the external pressure. What would happen is that as we withdrew the gun slowly it would reach a position where the pressure was just equal to that behind the bullet, which would be very gently released.

If we had "air oceans" we should see equally extraordinary effects. For instance, if we ever dig a mine about 30 miles deep, we should not be able to have a wooden chair in it. The chair would float! The pressure of the air naturally increases as we descend a mine, and at this depth its weight would be greater than that of wood, so that the wood would

float. Of course, human beings could not withstand this pressure and so this must remain a purely theoretical difficulty!

GRAVITY AND INERTIA

SCIENCE is by no means the dull subject it is usually considered and a little knowledge may be useful for the most everyday problems. For instance, suppose the cook half hard-boiled half a dozen eggs, and, by some mischance, muddled them up with the raw eggs, how would you distinguish between them without cracking the eggs? You would make use of your knowledge of inertia, the resistance which every body has to initial movement. Just spin the eggs with your finger and thumb. The raw eggs will stop spinning almost at once, but the cooked ones will continue spinning. This is because the interior of the raw egg is liquid. The liquid takes up the movement imparted to it only with very great effort and immediately starts to act as a brake, bringing the shell quickly to a standstill. The boiled egg is a solid mass and spins together. If you spin an egg that has been carefully blown it will stand up and turn on its point.

The reason for this is, of course, what we call centrifugal force, which may become sufficiently strong to "overcome" or modify gravity. We see examples of this in the motor-racing track with its banked sides, and the "Wall of Death" which enables gravity to be overcome and a motor-cycle to be ridden horizontally. A hollow paraboloid-shaped globe was once made which could be spun rapidly. People entered it and found that they could walk up the walls without losing the sensation of being upright, although their eyes showed them that their bodies made a right angle, with those of other people standing in the centre.

An amusing experiment has been performed showing that plants can be deceived in the same way. Small plants were grown on the rim of a wheel which was kept rotating. The

roots grew upwards because it felt downwards to them, and the stem grew downwards because it felt upwards! We have the same deception in the air. An aeroplane in a steeply banked turn may be almost at right angles to its normal flying position, but a passenger is quite unaware of anything different. If you threw a stone out of an aeroplane while turning it would appear to travel sideways instead of falling.

Now here is an interesting point. All bombs, big or small, when falling to earth "weigh" the same—that is, nothing! It is unfortunate that they get their weight back immediately they strike the earth! People find it very difficult to believe that a falling object weighs nothing. It can be demonstrated by dropping something held on spring scales—the pointer on the scales will swing backwards showing the decrease in weight. If you could follow the scales down in a dive, you would find the pointer went back to 0—for the object being weighed "loses" its weight.

A bomb, of course, falls in a curve because owing to its inertia, it starts with the same forward speed as the aeroplane from which it is released. But having no engine, it drops in response to the force of gravity at an increasing angle as it loses its forward momentum.

The force exercised by gravity is an acceleration of 32 feet per second, per second—that is, the bomb would be travelling 32 feet a second faster at the end of every second. Its speed would increase in this way to infinity if it were not for the air which resists it. There comes a point where resistance equals acceleration and this is the maximum speed for any falling body. If the air is very thin, the friction at high speeds may be such that the body is ignited—this is what happens to the majority of meteorites falling into the earth's atmosphere. A bomb dropped from an aeroplane sufficiently high would melt on the way down!

Returning to the fact that a freely falling body has no weight, we can understand why we get "that sinking feeling" in a lift. Our stomachs are literally "left behind" when the

lift starts and the momentary sinking feeling is due to their rapid acceleration to overtake the lift. If the lift fell freely, that is, with increasing acceleration, anyone inside it would have no weight and would be able to jump up to the ceiling. A chair might rise and float in air. Remember that objects "weigh" differently in different parts of the world—if a spring balance and a plain balance are used for relative comparison.

PERSPECTIVE AND STEREOSCOPY

THE fact that we have two eyes and not one is of far greater importance than most people imagine. If the human race were one-eyed it might have little idea of perspective. Indeed, Cyclops must have been at a great disadvantage when fighting because of his difficulty in judging distances! Our eyes are miniature range-finders, the distance between them being the base of the triangle the distance of whose apex we judge.

In the range-finder an image of the object is caught by two different lenses at the ends of a measured base, which may be a few inches or, in the case of a battleship, more than a dozen feet apart. The angle which the object makes with the base at each end is measured and, with the known length of the base, enables the distance of the object to be calculated by trigonometry. In actual practice, one angle of a range-finder is nearly always kept a right angle and only the other has to be measured. The trigonometrical calculations are, of course, performed automatically by "dials".

Our eyes work in the same way. What happens, in fact, is that we see a slightly different view of every object with each eye. The brain co-ordinates these two aspects giving the impression of distance and of the third dimension. The person with only one eye is handicapped in this way for he has difficulty in estimating distances. This is particularly noticeable when he is driving a car, but since his tendency is to overestimate, and he gradually acquires

the faculty of judging distances by other methods, he may still be a good driver.

A photograph, being flat, cannot reproduce the third dimension and there is no feeling that you can "see behind" objects in the foreground. The stereoscope enables specially taken photographs to be seen so that the objects stand out. The stereoscopic camera has two lenses and two plates side by side. Two pictures are taken, each showing a slightly different view of the object. The difference is so small that it cannot be seen in comparing the objects unless they are very close to the camera. These are placed in an optical apparatus so that only one view is seen by each eye.

An ingenious method of getting stereoscopic pictures is to take the left-hand one in red and the right-hand one in green. A pair of simple glasses are then worn which cut out all the light except red for the left eye and all the light except green for the right. Thus each eye gets a different view, with stereoscopic effect. Examined with the naked eye the picture seems a confused jumble of red and green lines.

THE MOON

MANY people have only noticed the moon properly since the introduction of the black-out. Yet our satellite is one of the most fascinating studies and plays a very important part in our life. The most obvious effect of the moon is the tides. These are high or low in accordance with whether the moon is working "with" or "against" the sun. The tide is of great importance to sailors, who demand "tide tables", predicting the times of high tide for any given place for days and even years ahead. The scientist supplies this by calculating the position of the sun and moon at future dates. But the time and height of the tides also depend upon the shape of the coast at the given point, the depth of water and other facts which have to be harmonised with the main data. This is possible only with the aid of a giant calculating machine, not unlike

the predictor which works out elevation and fuse setting for anti-aircraft guns.

There are many interesting facts about the moon. For instance, because it turns round in exactly the same time as it goes round the earth—a lunar month of about 28 days—we always see the same face. No one knows what is on the other side of the moon. Actually we can see a "little round the corner" at the moon's different phases, but four-fifths of the other side has never been seen.

Incidentally, the moon's phases are not, of course, due to it "waxing" and "waning" as the ancients supposed, but simply to the relative position of the sun. But it is interesting to see the persistence of the old idea in pictures which show a star twinkling between the horns of the crescent moon! If you look very carefully between the horns of the crescent moon you can just make out the shape of the complete disc by reflected light from the portion that is not visible.

Why does the new risen moon appear so much larger? Of course, it is only an appearance—not because it is nearer. It is actually a little further away, owing to the curvature of the earth. Many reasons have been advanced, but probably the real reason is that the size is an optical illusion due to the fact that when the moon is low we have objects with which to make a comparison. Look at the new risen moon through a rolled up newspaper and it immediately appears to diminish in size.

The moon is reputed to have all sorts of effects on the earth which are "not proven". People will tell you that if you sow seeds according to the moon you get much better results. The idea that the moon shining on the face of a child can make it an idiot is, of course, ridiculous—but it may give him a nightmare. "Moon madness" is not proved, but some people become unbalanced, during certain phases of the moon, and moon madness has been put forward as a defence for murder, it being claimed that a

prisoner was not responsible for his actions. Such defences are most unlikely to succeed! But we get the word "lunacy" from the notion of the moon's bad influence.

ABOUT LIGHT

LIGHT is something which no one understands properly. Even scientists cannot agree what it really is. At one time they believed it was a form of wave motion, at another that it was like a stream of fine corpuscles. Then they returned to the wave theory. Now they believe in both together—this being the only way to explain some of the ways in which light behaves!

Light does not come from the sun. The sun sets the ether in vibration and this vibration chances to produce in human beings the sensation of light. But it might just as well cause a flower to open, for light as we call it does not exist outside the human body, any more than does the smell of an onion. If a brick is dropped on your toe from someone's hand, you would not say that the pain had travelled from their hand to your toe!

The eye is a remarkable optical instrument, but an imperfect one, quite easily deceived in many ways. It cannot appreciate a succession of rapid movements, for it takes an instant to adjust itself. Thus a series of motions at a rate of over about 20 to the second seems to be continuous.

On this optical illusion is based the cinema. Between the pictures, shown at the rate of about 22 per second, a shutter passes in front of the projector and blots out all light from the screen, which for an instant is black. You spend much of your time at the cinema in darkness!—but although this black-out happens thousands of times every time you go, you have never seen it because your eye is not quick enough. If it were not for this shutter, the series of pictures would appear, not as continuous movement, but as a blur.

For the same reason a ball on the end of a rapidly whirling string looks like a wheel. But if you look at a rapidly moving

object, such as a train, through a fence, you can see it uninterruptedly. If you put a fine grating over a page of a book you cannot read what is underneath. But move the grating rapidly to and fro and you find you can read through it undisturbed.

The eye has an iris diaphragm like that of a camera. It opens and shuts so that, regardless how bright is the amount of light, the eye never receives more than a certain average. This is a very wonderful automatic device, but it has its disadvantages, since the diaphragm takes time to adjust itself to new conditions. When you step from a brightly lighted room into the night it appears pitch black, but after a few moments you begin to see things and perhaps a quarter of an hour later you find no difficulty in "seeing your way". This is due to the adjustment of the iris having been complete. A good tip if you have suddenly to face a light, and do not want to be blinded, is to close one eye. The other eye will be "blinded" after the light has passed, but the closed one can then be opened and is already adjusted for the darkness. This is very helpful for night driving when you have to pass other cars with bright headlamps.

The limitations of the eye make possible many tricks, or optical illusions. If you draw a bird on one side of a disc about the size of a penny, with a cage on the other, and then rotate the disc around its horizontal axis by means of a piece of string, you will see the bird enter the cage. The phenomena of retention of vision makes you "hold" the picture of the bird for the brief instant that elapses before the disc makes half a revolution and the cage appears, so that you then "hold" the cage until the bird appears again.

Because of the limitations of the eye, judging distances requires considerable experience. Colours are very apt to deceive the eye, particularly if they are dark. The eye is apt to estimate the height of a black box at the end of the room, for instance, as two or three inches higher than it would a white box. Distances are apt to be underestimated in dull

and misty weather, or overestimated in clear weather. The way to practise gauging distances is to look at something you know well—such as the distance a man is away from you, which can be estimated according to whether you can see his eyes clearly, whether you can see his features or simply a "blob". Practise constantly on men and you will find it easy to estimate distances with surprising accuracy.

The reason why rifle sights have to be adjusted for distance is, of course, that light travels normally in a straight line whereas a bullet's trajectory is slightly curved, dipping down to the earth. The greater the distance the more the "dip".

Of course, light may be curved or distorted by passing from one medium to another. The apparent bending of a walking-stick in water is well known. The same thing happens to a varying degree when light passes from hot air to cool. In its extreme form this refraction, accompanied by reflection, produces the mirage of the desert.

Draw a number of thick-lined concentric circles on a piece of paper. These "wheels" will appear to revolve if the picture is moved in a circular path.

To show that the eye has a blind spot draw a cross and a dot about 1½ inches apart; stare at the dot as the paper is moved towards the eyes. The cross will suddenly disappear.

Sometimes, after looking at a green light, a flash of red appears. This is a kind of "complementary after-image", due to excitation of the sensitive parts of the eye by one colour.

These are all ways in which the eye is *not* like a camera.

Light has weight. If a halfpenny could be heated to the temperature of the sun, the weight of light from it would knock down anyone within a radius of 5 miles or more.

A mirage is due to bending of the rays of light as they pass from hot to cold layers of air in the atmosphere. This is also what makes a dry road look wet from a distance, when the sun's rays are bent until they shine into the eyes.

OTHER KINDS OF LIGHT

When we talk of light in the ordinary way we mean "white light", which is a combination of many different vibrations. Only the sun produces true "white light". Artificial lights lack certain of the vibrations to a greater or lesser degree, generally at the blue end.

Just beyond the upper and lower limits of the visible spectrum, as we call this band of vibrations, are other vibrations of considerable value. We call them ultra-violet and infra-red because they are just a little shorter and a little longer than visible violet or red respectively.

Ultra-violet rays are those which produce the sunburn so much esteemed (but not the sun tan that comes out of a bottle). They produce no effect of light on the eyes. A lamp giving nothing but ultra-violet light, therefore, does not seem to be lit. But certain substances when placed in ultra-violet light "fluoresce", giving a light that can be seen by the eye. If objects are painted with one of these substances, they are visible in ultra-violet light. Some amazing effects can be produced in this way. Ultra-violet light has a slightly penetrative effect, and photographs taken by it on special plates give a "more than skin deep" portrait of the human body—very useful to doctors. The penetrative effect is not nearly so great as that of X-rays, which are much shorter.

Ultra-violet rays are also used for examining objects through a microscope, when the objects are so small that they would slip between the vibrations of white light and remain invisible however great the magnification.

Infra-red rays, because they are longer than red, are not so easily cut off by small particles of dust and moisture in the air. (It is for this reason, of course, that the setting sun looks so red—the light has to travel through a very thick layer of the atmosphere and all but the red rays are cut off. The sun looks red in a fog for the same reason.) Infra-red rays are slightly shorter and even more penetrating.

Photographs taken with a plate specially sensitive to

infra-red rays and with a filter cutting off the ordinary white light can reproduce very distant objects cut off from the eye by mist or dust. A picture taken from an aeroplane at a great height has shown a mountain 180 miles distant and, indeed, the limit with infra-red photography is probably only the curvature of the earth. The light and shade of objects does not reproduce in the same way as to our eyes—green trees are apt to look white in an infra-red picture because they reflect the rays well. Infra-red ray photographs can also penetrate much camouflage.

The rays do not produce tanning like ultra-violet, but have medicinal value for their warming effect.

Photographs on "infra-red" plates can be taken by the invisible light of a kettle of hot water or by the light of the hot engine of a motor-cycle.

WHAT CAUSES COLOUR

The light from the sun, a candle, or an electric lamp is a mixture of electro-magnetic vibrations and each of these vibrations has a different effect on our eyes when producing the sensation of colour. It is just a matter of convenience that we agree to call the sensation produced by a certain vibration red, another blue, and so on. The effect of all the vibrations together we call white. The absence of any, we call black. Actually if anything were perfectly black we could not see it at all—black things are those that absorb nearly all light, but not quite all.

The colour of any object depends upon its property of absorbing vibrations of certain lengths and reflecting the others to our eyes. A red pillar box, for instance, absorbs all colours except the red vibrations, which it reflects into our eyes.

Objects may not only reflect certain vibrations, but transmit them. Glass is "transparent" because it allows nearly all the light to go through—but some is reflected from the surface, otherwise glass would be quite invisible and we

should not be able to see a window pane, but only what was behind it. Some things, like gold leaf, are different colours by reflected and transmitted light. Hold a gold leaf up to the light and it appears green.

Light can be broken up into its components under certain conditions. A prism does it effectively—any piece of broken glass will do it more or less. The rainbow is produced by fine particles of moisture acting as a prism. The beautiful colours produced by a fine film of oil on a puddle in the road are not due to the "colour" of the oil but the refracting power breaking up the light into its constituent vibrations. Such an oil film may be as little as one molecule thick—less than a millionth of an inch and far too fine for the most powerful microscope to measure. This, incidentally, disposes of the story that Perkins thought of coal-tar dyes when he saw the effect of tar on a puddle. The dyes are made from coal tar by a long and involved chemical process and, although coal tar is the raw material, it is no more like aniline dyes than is aspirin, made from the same source.

If the sun was purple, white would not be our idea of "plainness". We would probably speak of a white dress as being a glaring white. It is a matter of custom dating from the birth of our Earth.

Light is not yet understood. Like motor-cars, and all other man-made things, artificial light is very inefficient. Only about 2 per cent of what we buy as energy in gas and electricity goes into light. The rest is wasted as heat. We are not so clever as the glow-worm in this respect. Motor-cars, too, waste about 75 per cent of the chemical energy—the fuel. So there is still plenty of room for improvement.

WHAT THE FUTURE MAY BRING

This does not mean fortune-telling but just some of the things that the curve of progress indicates as likely to come into everyday life. Covered-in streets, for one thing, so that weather will not interfere with our business. Aeroplanes

travelling round the world. Better heated houses. Buildings constructed in pre-fabricated sections, easily set up and easily removed to a better spot. Landing grounds for aeroplanes on roofs to save space. Escalators wherever possible to save time. Synthetic clothes, food and materials. Anything to help our brains and everything to prevent the need for physical effort.

SMELLIES AND FEELIES

UNDOUBTEDLY, in the not far distant future, attempts will be made to broadcast other things besides sound. At first this will surely be for entertainment purposes. A picture of a rose, for example, would have much more appeal if it were accompanied by the appropriate scent.

Scent may well prove to be one of the easiest of sensual impressions to broadcast. To-day, even, by choosing the right expressions I can suggest a smell over the telephone so effectively that the listener at the other end actually perceives it. When suffering from concussion men sometimes smell odours that are not present, which suggests that "smell" is merely the stimulation of certain brain cells.

Radio engineers, after they have successfully transmitted the sense of smell, will try to send the "feel" of things by wireless. While an actor is describing a fur, for instance, they will attempt to give the audience the feel of the skin.

No doubt first experiments will be very crude. So don't be surprised at first if you feel you are sitting on sharp rocks when actually the feel of a velvety lawn is being broadcast.

At last the greatest triumph of all will come when the engineer learns how to transmit matter. Matter will be turned into ether vibrations at the transmitting end, and at the receiving end turned back again into matter. It may be possible to put your pencil into a suitable apparatus, turn a switch and see it slowly disappear as it disintegrates into the constituent electrons and neutrons, which would be reassembled many miles away.

§VII

WONDERS OF THE WORLD

THE SEVEN WONDERS

The Classical Seven Wonders of the World were:

The Pharos of Alexandria;
The Colossus of Rhodes;
The Temple of Diana of the Ephesians;
The Pyramids;
The Tomb of Mausolus;
The Hanging Gardens of Babylon;
The Statue of Jupiter at Olympia.

The Seven Wonders of the last twenty years might be:

Television;
The Mount Palomar 200-in. Telescope;
The liner *Queen Elizabeth;*
The Boulder Dam;
John Cobb's 368.85 m.p.h. Railton car;
Infra-red photography;

Or anything else you prefer, including:

The Aeroplane;
Plastics;
"Sulphanamide" drugs;
Broadcasting.

The Seven Wonders of the next twenty years may be:

Aerodromes on Rooftops;
Television-Telephones;
Power from the Sun;
Moulded mass-production houses;
Long-range weather forecasts;
The £50 motor-car;
Weather-proofed streets.

Or another series beginning with the Transmutation of Matter.

TELEVISION

How does a moving picture get on to the screen of your television receiver?

First of all, the light, playing on the screen to produce the picture, comes from inside the set. It is necessary to make this clear, for some people imagine that the picture itself is transmitted in some mysterious way. This is quite impossible. What is transmitted is a series of electrical impulses or variations of an electrical current which represent the picture. These are of the same kind as are used to transmit the sounds that come from the loud-speaker, and indeed the sound signals could be turned into a picture, like the "snowflakes" seen on the screen when a motor-car, with its electrical gear, passes close to a television receiving aerial.

How then is a picture turned into a series of signals? It is, as yet, impossible to transmit the whole picture at once, so it is broken down into a number of small points, just like a picture for "half-tone" newspaper production. If these points are numerous enough and close enough together they will give the appearance of a continuous picture. In the case of television, the dots have to be produced one after another so quickly that they appear to be on the screen all together; by the time the last dot has disappeared the first one is being reproduced again.

This is complicated, in television, by the fact that we wish to give the illusion of movement. In the cinema this is done by showing a series of pictures one after another so quickly that the eye "carries forward" and interprets them as continuous movement. Provided the pictures are shown at the rate of about 25 a second, the illusion is complete. At slower rates the movements will appear jerky.

The television transmitter has, therefore, to break down a picture into many thousands of points and transmit them all in the space of less than one twenty-fifth of a second, being then ready to begin transmitting the next picture. This means, in practice, 160,000 impulses being transmitted

every one twenty-fifth of a second. These impulses have to be amplified, at transmitting or receiving ends, many millions of times without losing their correct relationship, and as their speed may vary from 30 to 3,000,000 cycles, amplification alone in television represents a wonderful achievement.

THE EMITRON CAMERA

In the television studio, the scene is photographed by an Emitron camera. This has an optical system like that of an ordinary camera, but the image, instead of falling on a photographic plate, falls on to a "mosaic" consisting of a great number of light-sensitive cells, each of which not only turns light into variations of an electrical current, but "saves up" its charge for one twenty-fifth of a second. This ingenious instrument solved many of the difficulties of lighting experienced by early television experimenters, who found they had to light the scenes very strongly in order to allow sufficient light to come from each "dot" on the picture.

THE CATHODE-RAY BEAM

The photo-electric cells, each, of course, insulated from its neighbours, are discharged in turn by a cathode-ray beam sweeping across them, and thus into the out-put circuit of the television receiver goes a series of electric charges or signals, representing the variations in light and shade of the picture. This happens every one twenty-fifth of a second, and the signals are first amplified in the region of 100,000,000 times and then broadcast by apparatus similar to that used for sound broadcasting.

At the receiving end the signals are picked up necessarily in exactly the same order as they have been broadcast. The signals now represent the variations in light and shade of a vast number of points on the picture, and the receiver has to convert them into shadows representing these tones. This is done after they have been amplified about 20,000 times by

the cathode-ray tube. The flattened end forms the screen of the television receiver. The cathode-ray tube has the property of emitting electrons in the proportion to the current fed to it, and when these electrons strike the fluorescent screen at the end they produce little specks of light.

The electric current for the cathode-ray tube is produced from the mains and it is merely varied by the signals which have been detected and amplified very much like those of sound. A complete change of picture is produced every one twenty-fifth of a second and the illusion of movement is thus reproduced on the screen.

PHOTO-MOSAIC

There are one or two points to notice. First of all, the cathode-ray which sweeps the photo-mosaic of the Emitron camera must be exactly synchronised with the cathode-ray in the television receiver. This is carried out by transmitting a synchronising signal which keep the two "in step", so that even if small variations occur at the transmitting end they do not matter, as the same small variations are produced in every receiver tuned in.

The photo-mosaic is one of the most important parts of the whole apparatus. It would be impossible to make photo-electric cells of the valve type small enough for the purpose, so the mosaic is made up of sensitised globules of silver, or some other substance, mounted on mica to ensure insulation. The mosaic is enclosed in a vacuum tube.

THE COAXIAL CABLE

Because of the particular type of signals which have to be transmitted, a short wave-length has to be used. This limts the distance at which the signals can be received, usually to about twenty miles. For the same reason it is not possible to transmit the variations over an ordinary telephone land-line, as with "acoustic" signals. If television signals are

to be sent by line, a special type of cable called a co-axial must be used; it consists of a great number of wires arranged in a particular way and carefully insulated. This cable is used for carrying the impulses from the television camera to the amplifiers which, especially in the case of outside broadcasts such as street processions, may be some distance away.

THE MONOTOR

Before being sent to the transmitter circuit the signals are "monotored". The monotor can see the picture on a screen and can handle those from several cameras at once, fading one into the other, changing from a distant view into a close-up, or superimposing one picture on another.

MAKING FILMS TALK

We have become so used to "talking pictures" that a silent film now seems strange, yet few of the millions who visit the cinema each week understand how the voices of their favourite stars are "bottled" in the studio, to be released later as often as required.

The sounds that we hear in the cinema are not those which were produced in the studio. The movement of the lips of the actors create the illusion that the sound is issuing from them; actually, however, it is coming from a number of loud speakers carefully placed with reference to the acoustic properties of the hall. Let us follow the sound back from our ears to the studio where the film was made some time previously.

SOUND

The sensation of sound is produced in our ears by vibrations in the air, the pitch, timbre and loudness of the sounds being due to the length, "shape" and width of the waves.

The sound waves lead us back to a loud-speaker, where they are generated by a board or piece of other material vibrating in response to electrical impulses. These impulses have come to the loud-speaker circuit from an amplifying

unit where their strength has been increased many thousands of times. From the amplifying unit we can trace them back to the projector at the back of the cinema.

SOUND-GATE

Below the optical system of the projector is a sound-gate, in which marks on the edge of the film are converted into electrical impulses representing sound, just like those which travel along our telephone wires. In front of the sound-gate, through which the film passes, is a photo-electric cell which has the property of modulating an electric current in terms of the intensity of the light falling upon its surface. Behind the sound-gate is a sconce of light, focused to shine on to the cell through the narrow "sound-track" at the edge of the film.

"FLICKERS"

This track looks rather like a very long temperature chart, and is, in fact, a relative photograph of the "ups and downs" of the sound waves produced in the studio. The light falling on the photo-electric cell flickers as it is cut off in varying degrees by the shadows on the sound track. The photo-electric cell, in response, produces "flickers" in the electric current passing through it, and it is these changes which, enormously amplified, govern the sounds you hear. The actual power for the production of the sound is supplied to the loud-speaker independently. The impulses from the photo-electric cell merely govern the energy.

The braying of an ass, the beautiful notes of a prima donna, the splash of a mountain stream, and the boom of artillery—all these come to the projection-room simply as shadows on the edge of a strip of film.

It is indeed possible to draw these shadows by hand and thus "reproduce" a voice that never spoke. Every sound has its characteristic "picture", and words have, in fact, been drawn in this way to "censor" a film, the original word being blotted out and the new one, drawn by hand, photographed

in its place. The work involved, however, is so tremendous that it would be impracticable to make a complete film of "ghost" voices in the same way as cartoon pictures are made.

SOUND SHADOWS

Before we leave the projector, note that since the sound-gate is below the gate which permits the light to shine through the pictures on the screen, the shadows on the edge of the picture do not represent the sounds accompanying that picture, but those accompanying the pictures a number of frames further back. Also, whereas the pictures are shown in jerks, with an interval of perfect blackness between them, the sounds are shown continuously, with no interruption, every one twenty-fifth of a second.

How, then, did the sound shadows get on the film? In the studio, when the film was being made, the sound-waves from the players' mouths struck a microphone. The process of the loud-speaker was reversed. Mechanical energy in the sound-waves was turned into modifications of an electric current. These were carried to the recording apparatus, in which, enormously amplified, they are applied to a lamp which "flickers" in response to the current, the light being focused on the edge of the film. If required, the sound can be recorded on a separate negative, and printed on to the visual negative afterwards, the greatest care being taken to synchronise the two cameras. The original sound quickly loses its energy and dies away, but the photograph of it is safely recorded, and, just as you can look at pictures of people long dead, so you can hear reproductions of their voices as they spoke many years before.

§VIII

SOUND

SOME SOUND FACTS

Sound is transmitted by waves or vibrations, the wave-length or number of waves a second deciding the pitch, and the amplitude, or height and depth of the waves, and loudness.

Sound requires a medium through which to travel. It cannot, like light, travel through a vacuum. Its speed depends upon the medium through which it is travelling. Thus, in air it travels at 1,142 feet a second, at average temperatures and pressures. It travels much faster in less compressible mediums. For instance, it travels in water at nearly 5,000 feet a second; through iron at 17,500 feet a second; and through wood at 11,000 to 16,000 feet a second, according to the type.

The difference between the velocity of light and the velocity of sound enables us to gauge the distance of anything which simultaneously makes a light and a sound. Thunder and lightning and the flash of a gun are examples. For practical purposes over short distances (up to several hundred miles), the velocity of light is so big in comparison that it can be called infinite. We have only, therefore, to time the seconds that elapse between spotting the flash and the arrival of the sound to get the distance. If the time is 3 seconds, then the flash is distant three times 1,142 feet—or 1,142 yards.

In the same way we can hear a train approaching better through the rails than through the air, and the difference in speed between two sounds, one travelling through air and the other through water or iron, will give us the distance.

By timing the arrival of a sound at three different points in a line at right angles to that in which the sound is travelling, we can calculate the distance of its source. This is called

"sound ranging" and involves very precise measurements which are carried out electrically and photographically. It is used for ranging guns.

Noise and sound are different things. Sound has regular vibrations; noise, irregular ones. The limits of the numbers of audible "vibrations" are roughly 16 per second and 3000–4000 per second. Below the sound limit, the vibrations affect the body rather than the ear—it is a physical blow. Above the limit, the vibrations are inaudible to human beings but may be audible to animals and birds. A dog can be called by a whistle so shrill that it cannot be heard by human beings.

When sound travels through air it moves the particles very rapidly and the resulting friction causes heat. The rise in temperature is very small, but can be measured electrically so as to time distant gunfire. In the hot wire microphone the sound vibrations are made to alter the temperature of a heated wire, the variations being measured electrically.

Sound can be reflected, just like light with a mirror. It is on this principle that aeroplane sound detectors are worked, the sound being reflected on to a microphone. It can also be partly refracted, or "bent", like light, when it passes from one medium to another.

Since layers of air at different temperatures represent two different bodies from the point of view of sound, noises may travel in curious ways on hot days. You may have noticed the sound of a motor cycle dying away and then suddenly becoming louder. This is probably due to a layer of hot air near the ground "refracting" the sound waves. You have also no doubt noticed that when a moving source of sound passes you—a train whistle or car horn—the sound seems to go flat. This is because your ear collected fewer vibrations during a given time. Fewer vibrations mean a lower note.

Very powerful sounds can cause concussion, the pressure wave striking a physical blow. Very high vibration sounds can cause damage by disintegration of the cells—not by force. It has been found possible to kill fish by these "ultra-sounds",

but there is no evidence that, except over very long periods, they can harm human beings. They can be used to kill harmful bacteria in milk, literally shaking them to pieces.

Insulating for sound, which is so important in modern buildings, is carried out with materials which are bad conductors of sound—asbestos, fibres and special plaster. The sound can also be reflected away from rooms, and care has to be taken that steel girders do not act as "wires". It is possible for sound to travel along girders so that a man dropping his boot in the top room of a large hotel is plainly heard in the lounge—although the man in the next room hears nothing.

MORE ABOUT SOUND

Sound travels to the brain through the bones of the head, as well as direct through the air to the ear drums. This is the principle of many acoustical aids for the partially deaf. Thomas Edison, who invented the gramophone, was made deaf by a "box on the ear" when he was a boy. The only way he could hear the gramophone which he had made was by playing it with the needle held tightly in his teeth. You can hear a "silent" gramophone yourself in this way—no one except yourself will hear anything. There is an electrical means of broadcasting dance music so that only the dancers can hear by wearing special head-phones.

Sound can be "scrambled" electrically, made unintelligible and then returned electrically to its original vibrations. This method is sometimes used for coding telephone wireless messages—no one who picks up the conversation can understand it without the key to "unscrambling". Sound can also be "scrambled" by running a gramophone backwards with the hand. A piece of classical music is apt to sound like a Chinese funeral march, which only shows that the small difference between the sublime and the ridiculous depends upon the taste of the hearer.

A perfect reproduction of someone saying words which

they never uttered can be drawn by an expert and then photographed. When passed through the reproducing machine the photograph reproduces the words they never spoke.

A very clever birthday card consists of a picture of a ventriloquist's dummy on a card. From the back of his head projects a piece of clock spring. When the thumb-nail is drawn rapidly along this spring, the dummy "says" aloud: "A happy birthday". The explanation is, of course, that the wire is impressed with fine corrugations corresponding to the sounds. The thumbnail acts like a needle of a gramophone, and the card as a sounding board.

IF YOU COULD HEAR LIKE A BIRD

Birds can hear the rustle of worms one foot under the ground. If you could hear the worms you would say, "How nasty", every time you sat down. The worm can hear the thud as the bird alights on the turf. Next time you take a swipe at a golf ball notice, if you hit it, that any worm within quite a large radius will suddenly keep still because it has felt the shock. Worms are sensitive to low speed vibrations and if you took one to the theatre it would only hear the drums of the band.

So perhaps it is lucky for you that your senses have become atrophied. If you had the hearing of an antelope you could not stand civilised life. An apparatus made to amplify sounds so that you heard like an antelope would make it possible to hear what people were saying about you in houses across the street. One can learn a lot from simple science—not always to one's advantage.

SOUND IDEAS

Sound plays odd tricks. If you were addressing a meeting of enthusiasts in a big hall on the radio and an old friend of yours was listening-in in Australia with a pair of headphones, he would actually hear your voice sooner than another friend

who was sitting at the back of the hall where you were speaking, because light and radio travel at the rate of 186,000 miles per second, and sound at only 1,100 feet per second.

Town-criers can make their voices carry well, and a mechanical loud speaker can sometimes be heard as far distant as 14 miles!

The loudest sound in history was the volcanic explosion of the island of Krakatoa in 1883, the waves of which travelled three times round the world and lasted for several days. (Or so it is said!)

HEARD MELODIES ARE SWEET

The origin of music is wrapped in mystery. As creatures which crawled out of the sea and lived rhythmically according to the ebb and flow of the tides, we respond throughout our whole lives to rhythm, and it is rhythm that rules music, which after all is merely the setting into motion of the regular waves of sound. Probably the first music was the wailing of primitive tribes as they swayed their bodies rhythmically, accompanied by hand-clapping in rhythm. In Greece, music was closely associated with astrology, and the seven-stringed lyre used to have each of its strings named after the seven planets. The ripple of the waves, the sigh of wind in the reeds, even our own breathing, are all part of the music, the rhythm of life.

MORE FAMILIAR SOUNDS

The loudness of sound is measured in units called "decibels", one decibel being roughly the threshold of audibility. A whisper at a distance of two yards is about 10 decibels. The roar of an aeroplane engine close to is about 120 decibels; 140 decibels is about the limit of endurance of the human ear.

The noise of normal breathing is, at a distance of 1 ft., 10 decibels. Average conversation is 65 decibels. The noise of a passing motor lorry 89 decibels. A lion's roar is 95. The

gentle rustle of leaves 20 decibels, and a small field-cricket shrills his call at such a high pitch that it is far beyond the range of human hearing.

NOTES FOR MOTORISTS

When you glide swiftly past a wooden fence in your limousine (Austin Seven to you) you will often have noticed a swishing noise as you pass, and if observant, will perhaps have wondered what caused it. Well, it is the reflection of noise due to tyres and bow wave. The noise strikes the fence as it passes and is reflected back to your ear.

A sound mirage is sometimes to be noticed on a hot day. A noisy car passes and the noise dies away; suddenly it appears louder as distance increases. This is because the sound is reflected from hot layers of air rising from the ground.

RESONANCE

Resonance plays queer tricks. A well known singer is said to have cracked a glass by singing a note of certain pitch close to it. If two tuning forks of the same pitch are placed side by side and one made to vibrate, the other will vibrate also because of resonance.

§ IX

FACTS AND FIGURES

INTERESTING FACTS

THE weight of the earth is 6,487,000,000,000,000,000,000 tons. Always pressing down on it are 4,900,000,000,000,000 tons of air. Its surface area is 196,500,000 square miles, one quarter of which is dry land and three-quarters is sea.

* * *

THE standard width of a railway track is 4 ft. 8½ in. The reason for this is quite unromantic. It was the distance between the rails of the wagon-way on which Stephenson built his first locomotive and he used it to save trouble. The G.W.R. gauge was originally 7 ft. wide. On May 22nd 1942, they announced that "it was fifty years ago to-day that we converted from broad to narrow gauge." The majority of European countries adhere to the standard gauge. The exceptions are Ireland (5 ft. 3 in.), Russia (5 ft.), and Spain and Portugal (5 ft. 6 in.).

* * *

A BARRAGE balloon full of air, twenty-one pounds of soot, fourteen pounds of hydrogen, three pounds of chalk and smaller quantities of about 13 other elements would represent the raw materials of the human body. Some of the other elements are silicon, iodine, sodium, magnesium, iron, chlorine, salt, phosphorus, potassium and zinc.

* * *

MEASURED from the centre of the earth, the highest piece of land in the world is not the summit of Mount Everest but that of Mount Chimborazo in Ecuador. Although Chimborazo is only 20,700 feet, compared with Everest's 29,140 feet, the slight flattening of the earth at the poles, or

more correctly bulging at the equator, results in 20,000 feet above sea level at the equator being very much further from the centre of the earth than 29,000 feet in the tropics.

THE effects of high pressure are astonishing. A diver who attempted to descend to a great depth in an ordinary suit might be almost compressed into his helmet. Under a pressure of 300,000 lb. to the square inch, hydrogen gas passes easily through a two-inch steel wall. Rare gases can now be added to a diver's air supply to prevent absorption of nitrogen in the blood or to avoid "the bends", a disease which used to attack divers severely if brought to the surface too quickly.

* * *

ONE quarter of the hymns commonly sung by Christian communities were written by Germans—but that was before Hitler's time.

"PIGEON POST" during the siege of Paris in 1870–71, brought nearly 60,000 dispatches and 1,000,000 letters into the city. The microscopic size of the letters, reduced by photography, enables a single pigeon to carry several thousand "pages".

The *Santa Maria*, in which Columbus set sail on his famous voyage, was regarded as a prize ship in those far-off days. In peacetime *Queen Mary*, speeding at 35 knots, carrying from 3,000 to 4,000 passengers, crossed from Cherbourg to New York in 4 days, and her dining saloon alone could accommodate Columbus's whole fleet of 30 ships!

EN Dr. Beebe, American scientist and explorer, went far er water in his bathysphere it was so dark on the ocean

floor that he could not see. He was not fitted with phosphorescent headgear like many deep-sea monsters!

THE Australian Defence Department decided in 1939 to abolish "red tape". The red tape used for so long to tie together bundles of documents was replaced by white tape. No doubt it possesses similar qualities!

THE BIGGEST, THE HIGHEST, THE LONGEST . . .

THE MORE WE ARE TOGETHER . . .

There are about 33 towns in the world with a population of 1,000,000 or more. They are, in order of size:

London, New York, Tokio, Berlin, Shanghai, Chicago, Paris, Moscow, Osaka, Leningrad, Buenos Aires, Philadelphia, Vienna, Detroit, Rio de Janeiro, Calcutta, Canton, Peking, Nanking, Sydney, Los Angeles, Warsaw, Bombay, Hamburg, Glasgow, Barcelona, Montreal, Cairo, Rome, Milan, Birmingham, Budapest and Madrid. The first twelve have each a population of 2,000,000 or more.

LONG AND SHORT OF IT

The longest river in the world is the Amazon, 4,000 miles. The length of the Nile is about the same. If the Missouri and Mississippi are reckoned together, their length is 4,500 miles; the length of the Thames is 210 miles.

IN THE CLOUDS

The highest mountain in the world is Everest, 29,141 feet, not yet climbed, but conquered by the aeroplane. All the other greatest peaks are near it—Godwin Austen Peak (also known as K.2) and Kanchanganga, each about 1,000 feet lower.

Outside the Himalayas, the highest peak is Illampu in the Andes—25,250 feet.

Mont Blanc is 15,780 feet; Ben Nevis, the highest mountain in Britain, is 4,400 feet; and Snowdon 3,560 feet.

Long Drops

The highest waterfall in the world is believed to be in Venezuela, 5,000 feet. Several other falls in New Zealand and California exceed 1,000 feet. The famous falls are comparatively short, but have much greater volume of water. Victoria Falls, on the Zambesi, are 400 feet high; and Niagara, 167 feet.

Man-Made

The longest canal in the world is the Gota, 115 miles. Suez is 100 miles—twice the length of the Panama. The Albert Canal in Belgium and the Kiel Canal in Germany are both longer than the Panama.

GOLD FOR THE TAKING

There is more gold in the sea than men have ever managed to get out of the land. The amount varies from place to place, but, at its lowest, is about 150 lb. per cubic mile of sea water and at its best is 3 tons per cubic mile. Multiply this by the number of cubic miles of ocean, and you will see that it runs into a good many thousand million pounds' worth of gold; enough to make every person in the world wealthy. The snag is the difficulty of extracting it. The gold is so evenly distributed that it costs many hundreds of pounds to treat each cubic mile of sea water.

We are apt to think of sea water as consisting chiefly of water and salt, but there are many other substances dissolved—in small quantities it is true—but when the vast extent of the oceans are considered, the sea actually represents a tremendous source of valuable raw materials. Here are some of the amounts of various substances in a cubic mile of sea water:

117,000,000 tons of salt;

5,950,000 tons of magnesium;
8,250 tons of aluminium;
283,000 tons of bromine;
550 tons of copper—enough to make thousands of miles of wire;
94 tons of silver;
192 tons of iodine.

The sea also represents a tremendous source of power. We know the Gulf Stream, crossing the Atlantic, warms the British Isles. But we do not often stop to think what the warmth of this current represents. To get the same effect by burning coal, we should need a furnace capable of consuming 2,000,000 tons of coal *every minute!*

THE ORIGIN OF FIRE

There is much controversy as to the period when Man first came to use Fire. Ancient remains shows that Man knew fire at least a million years ago, but how he came to use it must always be a matter of speculation. Possibly, Man was in possession of fire in the Quarternary period, for remains of hearths, fuel and even blackened cooking utensils, have often been excavated.

Another of the very earliest uses Man must have made of fire was that of driving animals from the forest or jungle into his traps.

The three principles used by Man in fire-making must have been:—friction, fire-making by sparks from minerals, and fire-making by the compression of gases.

WIND

In Britain wind velocity seldom exceeds 90 m.p.h., but abroad in bad storms it may reach more than 100 m.p.h.

Some facts and figures from a wind scale, compiled in 1805 by Admiral Sir Francis Beaufort and still in use, gives some interesting details of wind speeds at ground level.

A gentle breeze at 10 m.p.h. sets small leaves and twigs in

constant motion and extends a light flag. A strong breeze at 27 m.p.h. sets large branches in motion, makes telegraph wires whistle and umbrellas open with difficulty. A fresh gale at 42 m.p.h. breaks twigs off trees and generally impedes progress. A gale at 59 m.p.h. (seldom experienced inland) uproots trees and causes structural damage.

In the Great Storm of England, on November 26th, 1703, 8,000 persons lost their lives in the South of England; the Eddystone Lighthouse was destroyed and the Bishop of Bath and Wells and his wife were killed in their beds in their Palace. In Kent county alone 17,000 trees were torn up by their roots.

SOMETHING ABOUT ROADS

The most primitive roads in Britain were the old trackways worn by early men and animals through woods and over the downs. Then came the famous Roman roads, many of them along the same tracks, but built up with stones and earth. When these fell into disrepair centuries after, Macadam built better roads on the same plan, but filling in the angles between big stones with little ones. To-day we hear of other and stranger materials. There have been rubber roads, glass roads, cotton roads, brown-paper roads, and—queerest of all—roads in India made of molasses, which is said to be excellent in hot climates. By the way, one of the oldest roads in this country is the Harroway, which runs from Marazion in Cornwall along the south to Dover.

BOOTS, BOOTS, BOOTS

It is difficult to squeeze a right-hand foot into a left-hand shoe in these advanced times, but before the 19th century there were no lefts or rights at all (in boots and shoes), so when you got up in the morning you could just slip your feet into your boots any way you wished. Boots have been worn since earliest days and have been in many strange shapes. Now they are hand cut from the finest of skins, pressed out,

sewn and finished by machinery, and the industry gives employment to probably as many as 150,000 persons in Great Britain.

NOTES ON PAPER

The trees you saw on your peacetime holiday in Canada may have gone to make the paper of this book, for wood pulp with rag and esparto grass is used for most paper to-day. Logs are dissolved with sulphur and other solvents until they are pulp, other materials are added according to the type of paper required. Some large newspaper proprietors actually own forests abroad in order that they may always have a plentiful supply. Egyptian papyrus, or reed paper, was probably the earliest known. In Britain there are over 5,000 newspapers and periodicals published each year, so we need plenty of trees to keep up the number. Or do we?

PURE WATER FROM SEWAGE!

It may sound incredible, but from great tanks of one of Britain's largest sewage works much of the sewage of Greater London is converted into harmless and inoffensive material and emerges purified, cleaner than river water, 500 million gallons of it in a single day to be carried out to sea.

RAGS AND BONES

There is no kind of rag or bone which is useless. This was true even before the present war gave "salvage" a new value. £12,000,000 a year has been made in France from the rag and bone trade.

Rags are among the most valuable things found in your dustbin. A huge trade is done in "shoddy". Suitable rags are chemically cleaned and disinfected, after which they are torn to shreds by machinery. The value of the rags varies with the quality—but a fine Savile Row suit after it has been ruthlessly shredded by these machines may be worth two shillings a pound. This industry has now a capital

running into hundreds of millions and more than one fortune has been made in Yorkshire out of "shoddy".

Bones, which are generally classed with rags, are used in several ways. They may be used for making gelatine and the phosphorus in them is used in making fertiliser. In war-time they are needed for munitions.

If all the rubbish in Great Britain collected from domestic dustbins was turned into electricity, over a thousand million units of electricity in one year would be produced. You put into your dustbin not only countless millions of atoms of useful elements, but also hundreds of horse-power of potential energy.

IMPOSSIBILITIES BECOME FACTS

It Can't Be Done . . .

. . . is what Napoleon told Robert Fulton when that great engineer suggested building steamships to travel down the Danube. Napoleon argued that the current of the river would carry the rafts that had always been used much faster than any steamship could hope to travel.

. . . is what German medical experts told Schleich in 1892 when he suggested that operations should be carried out under local anæsthetics. Less than ten years later operations were being carried out in this way almost as a matter of course.

. . . is what the British Chief of General Staff said of war planes in an official minute in 1913. His actual words were: "Flying will never get beyond the experimental stage and, in any event, would be far too dangerous in war." When the first German plane was brought down by fire from a gun mounted in a French plane, the French public refused to believe it until the pilot repeated his feat!

. . . is what Sir William Crookes, the great scientist, said

of feeding the world by 1932. He was speaking at the British Association in 1898 and said: "Should all the wheat-growing countries add to their area to the utmost capacity, on the most careful calculation the yield would only give us just enough to supply the increase amongst the bread eaters till the year 1931." He overlooked the possibilities of better cultivation.

. . . is what they said in 1910 about flying the Atlantic. A number of famous men wrote to a paper. Typical of the answers was that of the Hon. C. S. Rolls, a distinguished pioneer aviator: "Owing to the lightness of the air as a medium in which the aeroplane has to operate, I do not think that it will ever be used for carrying either goods or a large number of passengers." Sir Hiram Maxim wrote: "I should like to say at once that I do not think the aeroplane, despite the sanguine view which some may take, will ever be a popular means of conveyance with the crowd." The Atlantic was flown less than ten years later. It is now flown as a matter of course.

. . . is what they told John Ericsson, inventor of the first screw propeller in 1836. Sir William Symonds, Surveyor of the British Navy, said in his report: "Even if the propeller had the power of propelling the vessel, it would be found altogether useless in practice because, the power being applied at the stern, it would be impossible to make the vessel steer." The Admiralty once said that steam would be the downfall of the Navy!

. . . is what numerous people said in letters to the papers when the New York Y.M.C.A. announced in 1881 that it would give typing lessons for women. They argued that "the female constitution would break down under the strain!"

. . . said Simon Newcomb at the end of the 19th century,

speaking of heavier-than-air flying. He proved it thus: "The demonstration that no possible combination of known substances, known forms of machinery and known forms of force can be united in a practicable machine by which we will fly distances through the air, seems to the writer as complete as it is possible for the demonstration of any physical fact to be. May not our mechanicians be ultimately forced to admit that aerial flight is one of the great class of problems with which man can never cope and give up all attempts to grapple with it?" Simon Newcomb was a great American scientist and there were no substances, forms of force or machinery used by the Wright Brothers of which he did not know. It is very risky to attempt to define the impossible nowadays. Most "facts" are really matters of opinion.

WEIGHTS AND MEASURES

USEFUL FIGURES

SIXTY m.p.h. equals 88 ft. per second. An aeroplane travelling 240 miles an hour is covering 352 ft. every second. In this time the maximum number of rounds that could be fired by a Bren gun is about 9. No wonder planes are hard to hit!

The earth is just under 93,000,000 miles from the sun. Light travelling at 186,325 miles per second takes over eight minutes to reach us from the sun.

The weight of a standard brick is about 7 lbs., so that 100 bricks weigh 6 cwt. 2 stone; but they may weigh a good deal more if they are wet.

* * *

A quartern loaf is one of 4 lbs., and a 112 lb. sack of flour should make 36 quartern loaves.

A man running a hundred yards in 10 seconds is travelling at approximately 20 m.p.h. If you run a mile in 5 minutes you average 12 m.p.h.

Normal atmospheric pressure is 15 lb. to the square inch and will raise a column of mercury 30 inches. A pressure of two atmospheres is, therefore, equal to 30 lbs. to the square inch.

USEFUL TEMPERATURES

WATER freezes at 32° F.; boils at 212° F.

Alcohol boils at 172° F., and motor spirits round about this figure, depending upon the exact contents.

Lead melts at 617° F.; steel at 2,700° F.

The average body temperature is 98.6° F., but no one has a perfectly "normal" temperature, the thermometer showing a variation of a fraction of a degree. Your body temperature does not rise when you become hot through exertion or sitting in the sun, but only through "feverishness".

Mercury freezes at 39°; hence it is no good for thermometers in countries experiencing very low temperatures. There alcohol is used. It does not freeze until 180° F.

We use the terms "tepid" and "scalding," but they are very approximate—indicating not so much temperatures as feelings which may be easily deceived. 120° and 170° might be good approximations for the temperature of tepid and scalding water.

USEFUL MEASUREMENTS

VERY often no weights, rulers, etc., are available. For such emergencies the following rough guides which are very easily memorised will be found useful.

A pint of pure water weighs 1¼ lb.

A gallon of water weighs about 10 lbs.

A cubic foot of water weighs 1,000 oz. (62½ lbs.).

A penny is roughly 6–5th of an inch in diameter. Therefore ten pennies placed side by side cover a distance of 1 foot.

To measure an inch, use a halfpenny. It is 1 inch in diameter.

If the weights from the scales are missing, you can weigh your letters by placing three pennies or five halfpennies on the left-hand side. They weigh one ounce. All coins used for weighing should be fairly new—old and worn coins may weigh considerably less.

The weight of petrol in a 2-gallon can is about 15 lbs.

Your body provides two useful measures of time. Normal people take 18 breaths per minute and the normal heart (or pulse) beats 72 times a minute approximately.

To tell the speed of a train count the number of telegraph poles passed in one minute and multiply by two.

A FEW MORE WEIGHTS AND MEASURES

One sixpence = ¾ inch.
Five pennies in a row = 6 inches.
The nailjoint of index finger or one halfpenny = 1 inch.
Span of thumb and index finger = 7 inches.
Span of thumb and little finger = 9 inches.
Span of wrist to elbow = 10 inches.

3 pennies = 1 ounce.
1 teacupful = ¼ pint.

1 breakfast cupful
1 tumbler
} = ½ pint.

SOME DIFFERENT MILES

We all know that the last mile is always the longest, also that the short mile of the countryman explaining the way is often two of the townsman's miles. In actual fact there are quite a number of different miles in addition to the English Statute mile of 1,760 yards. Here are some of the others:

	Yards		*Yards*
Nautical Mile ..	2,027.3	Polish Mile ..	4,400
Irish Mile ..	2,240	Spanish Mile ..	5,028
Scots Mile ..	1,984	Geographical Mile	2,026.6
Italian Mile ..	1,467		

The league is often called three miles. The French league is 3,666 yards. The nautical "knot" is, of course, a measure of speed, not of distance.

ROMAN NUMBERS

Very often we see a book "Published in MCMIII," or a sign-post marked "LVI miles to London." Roman numbers are definitely going out of fashion, for they are clumsy compared with our Arabic numerals, but it is very useful to know your way about. Doctors, of course, still use them in their prescriptions in the hope that you will not be able to understand what they have written!

Here is a brief guide to Roman figures: the I, II, III, IV,

V, etc., are quite straightforward. X for 10 is also familiar. It is when we get to the L's and C's that we are apt to lose ourselves. Actually there are only four letters to remember:

L—50 C—100 D—500 M—1,000

All other numbers are combinations of these with the I, II, III numbers, which are added or subtracted from X, L, C, etc. Thus IX is 9, XC is 90, CC is 200. The year MCM is 1000 plus 1000, minus 100, or 1900. MDCCC is 1000 plus 500 plus 300, or 1800.

THE TIME ROUND THE WORLD

To find the time at the places given below, *add the hours and minutes* stated to Greenwich Mean Time.

Perth, Australia—8 hrs.
Sydney, Australia—10 hrs.
Shanghai—8 hrs. 5 min. 43 sec.
Denmark—1 hr.
Egypt—2 hrs.
Fiji—11 hrs. 53 min. 44 sec.
Germany—1 hr. Also Switzerland, Sweden, Malta.
Italy—1 hr.
Japan—9 hrs.
Cape Town—2 hrs.
Singapore—6 hr. 55 min. 25 sec.
India—5½ hrs.

From the following *the time must be subtracted:*

Argentine—4 hrs. 16 min. 48 sec.

Canada—5 hrs. in the east, 6 hrs. central, 8 hrs. British Columbia.

Ireland—25 min. 21 sec.

U.S.A.—from 5 hrs. to 8 hrs. in four zones from east to west.

GERMAN MEASUREMENTS

GERMANY uses the Metric System with German names as follows:

Stab for *metre;*
Neuzoll for *millimetre;*
Strich for *centimetre;*
Kette for *decametre;*
Kannr for *litre;*
Neuloth for *decagram;*
Centner equals 50 kilograms;
Tonne is 1,000 kilograms.

CONVERTING FRENCH AND ENGLISH MEASURES

ONE metre equals 1·0936 yards so that for ordinary purposes on short distances a metre and a yard can be taken as equal.

For longer distances adding one yard for every ten metres will give a close approximation, i.e. 100 metres equals 110 yards (actually 109·3) and 1,000 metres equals 1,100 yards (actually 1093).

This illustrates how delightfully simple the manipulation of French weights and measures can be. To multiply or divide in the metric system you simply move the decimal point to the right or the left, one place for each ten.

One kilogram equals 2·204 lb. If you find difficulty in remembering this, just remember that 10 kilograms equal 22 lb., or that 1 kilogram is very nearly 2⅕ lb. Sweets, etc., are sometimes sold by the 100 grammes, which is approximately 3½ oz.

The French measure distances, etc., in kilometres—1,000 metres. An easy way of converting kilometres into miles is to multiply the kilometres by five and divide the answer by 8, for five miles equal eight kilometres. Thus 15 kilo-

metres are 9 miles three furlongs—the division by eight has the advantage that any remainder is in furlongs.

The liquid measure is the litre, equal approximately to 1¾ pints. A half-litre of wine, therefore, is less in volume, although not necessarily in alcoholic content, than a pint of beer.

For small lengths the French use the centimetre and the millimetre (one-tenth of a centimetre). Just over 2½ centimetres equal an inch.

The value of the French franc against the pound varies from time to time, but has been fairly steady round 175–6 to the £. For very rough approximations this makes a penny equal to 75 centimes. To convert the price of an article marked in francs very approximately into English money, divide the number of francs by nine and the answer is in shillings. Thus something marked 108 francs would be 12s. This is only approximate—the correct figure would be 12s. 4d. and the underestimate of the amount will increase as the number of francs increases.

Temperatures on the continent are measured on the Centigrade scale on which water freezes at 0 degrees and boils at 100. To convert Centigrade into Fahrenheit—the scale used in Britain—multiply by nine, divide by five and add 32. For instance, 28 degrees C. equals, roughly, 82 degrees F. It is necessary to add the 32 because this is the freezing point of water on the Fahrenheit scale.

SOME COMMON MEASURES

A quartern loaf of bread—4 lb.
A peck of flour—14 lb.

Sack of potatoes—112 lb. (But it only contains about 105 lb. of potatoes, the rest being earth, etc.)

Quire of paper—24 sheets.

Ream of paper—20 quires, 480 sheets.

An ounce avoirdupois (the ounce generally used)—437·5 grains.

An ounce of gold or silver (troy) or apothecaries' measure—480 grains.

Hogshead of wine—about 26 dozen.

Hogshead of beer—54 gallons.

Hogshead of French wine—43–46 gals.

Hogshead of rum—45–50 gals.

Chaldron of coke—12 sacks, each three bushels or about 1 cwt.

Carat (weight of diamonds, etc.)—3.086 grains.

Nautical mile—1·151 miles, equal to 1,000 fathoms.

Fathom—6 ft. Cable's length—120 fathoms.

MEASURES OF WEIGHT

16 drams = 1 ounce (oz.).
16 ounces = 1 pound (lb.).
14 pounds = 1 stone.
28 pounds = 1 quarter.
4 quarters = 1 hundredweight (cwt.).
20 hundredweight = 1 ton.

TROY WEIGHT

24 grains = 1 pennyweight (dwt.).
20 pennyweights = 1 ounce.
12 ounces = 1 pound.
100 pounds = 1 hundredweight.

MEASURE OF CAPACITY

4 gills = 1 pint.
2 pints = 1 quart.
4 quarts = 1 gallon.
2 gallons = 1 peck.

4 pecks = 1 bushel.
8 bushels = 1 quarter.
36 bushels = 1 chaldron.

MEASURES OF LENGTH

12 inches = 1 foot.
3 feet = 1 yard.
$5\frac{1}{2}$ yards = 1 pole, rod, perch.
40 poles = 1 furlong.
1,760 yards or 8 furlongs = 1 mile
3 miles = 1 league.

MEASURES OF AREA

144 sq. inches = 1 sq. foot.
9 sq. feet = 1 sq. yard.
4,840 sq. yards = 1 acre.
640 acres = 1 sq. mile.

BELLS AND WATCHES ON BOARD SHIP

Midnight	to 4 a.m. ..	1 to 8 bells	.. Middle watch
4 a.m.	to 8 a.m. ..	1 to 8 bells	.. Morning watch
8 a.m.	to noon ..	1 to 8 bells	.. Forenoon watch
Noon	to 4 p.m. ..	1 to 8 bells	.. Afternoon watch
4 p.m.	to 6 p.m. ..	1, 2, 3, 4 bells	.. First dog watch
6 p.m.	to 8 p.m. ..	1, 2, 3, 8 bells	.. Second dog watch.

The Bell is struck every half-hour.

THE MORSE CODE

A. —	J . — — —	S . . .
B — . . .	K — . — .	T —
C — . — .	L . — . .	U . . —
D — . .	M — —	V . . . —
E .	N — .	W . — —
F . . — .	O — — —	X — . . —
G — — .	P . — — .	Y — . — —
H	Q — — . —	Z — — . .
I . .	R . — .	

1 . — — — —	4 . . . . —	7 — — . . .
2 . . — — —	5	8 — — — . .
3 . . . — —	6 —	9 — — — — —

WHAT THEY ARE PAID

Archbishop of Canterbury	£15,000
Prime Minister	£10,000
Lord High Chancellor	£10,000
Cabinet Ministers	£5,000
Dean of Westminster	£3,000
First Sea Lord	£4,525
Leader of Opposition (payment now suspended)	£2,000
Parliamentary Secretaries	£1,500
Members of Parliament	£600
Holder of Victoria Cross	£10

ONE TO TEN IN THREE LANGUAGES

English	*French*	*German*
One	Un	Eins
Two	Deux	Zwei
Three	Trois	Drei
Four	Quatre	Vier
Five	Cinq	Funf
Six	Six	Sechs
Seven	Sept	Sieben
Eight	Huit	Acht
Nine	Neuf	Neun
Ten	Dix	Zehn
One Hundred	Cent	Hundert
One Thousand	Mille	Tausend

§X

WAR AND THE SERVICES

WHAT WE OWE TO WAR

Most people think of war as wholly destructive. This is not altogether true. Many inventions primarily designed for war have proved of great use in peacetime. We do not now beat our swords into ploughshares because we do not use swords, but we adapt modern armaments to peaceable uses.

Poison gases invented for service during the last war were afterwards used for ridding cattle of pests on their skin, for destroying prickly pear by inoculation, for killing locusts and other pests. Apparatus invented for distributing liquids from aeroplanes have been used for spreading fertilisers and seeds from the air.

The flame-thrower, invented by the Germans, has been adapted for the destruction of strongly-rooted weeds such as blackberries.

The amount of experimental work done on caterpillar traction in connection with tanks made possible the numerous types of tractor and road-making vehicles now in use.

Work carried out on underwater acoustics for tracking submarines led to improved methods of sounding and added to the safety of ships.

Canning was invented as the result of a prize offered in France for an improved way of preserving food for troops. Margarine was invented as the result of a prize to find a fat substitute for butter in wartime.

New and greatly improved methods of treating wounds and fractures were discovered by surgeons during the 1914–18 war, with great benefit to casualties in peacetime. Modern plastic surgery had its origin in the last war, when it saved thousands from permanent disfigurement. The knowledge gained has been invaluable in treating victims of road accidents in time of peace.

The fixation of atmospheric nitrogen for use as a fertiliser, as a base for explosives and many other products, was a direct result of the Allies blockade which deprived Germany of natural nitrates. German chemists in the present struggle have been forced to see if they can get sugar from coal and other sources.

An interesting plan is to seek uses that can be made in normal times of weapons now being used in war.

The experience gained by parachute troops may lead to this becoming a common way of descending from non-stop air liners. The passenger will just ask to be "dropped off" near his home.

Magnetic mines provide a way in which ships could be warned when approaching shoals, reefs or rocks in darkness or fog. The mine would be permanently anchored and instead of exploding would emit a signal when a ship approached.

Probably you can think of other adaptions for yourself.

PROPHETS OF GLOOM

"There is scarcely anything around us but ruin and despair," said William Pitt about his own day, and not long afterwards Wilberforce declared: "I dare not marry, the future is so dark and unsettled." Yet Britain was just about to enter a Golden Age of reform, freedom and prosperity!

In 1849 Disraeli wrote: "In industry, commerce and agriculture, there is no hope;" and the Duke of Wellington, two years later when he was dying, declared: "I thank God I shall be spared from seeing the consummation of ruin that is gathering around." They were as mistaken as Lord Shaftesbury, who declared in 1848: "Nothing can save the British Empire from shipwreck."

These were politicians and great statesmen. Yet they were completely wrong. Isn't it just possible the gloomy prophets of to-day will seem equally ridiculous in a year or even a week's time?

CAVEMEN—COLOUR—KHAKI

It is interesting to learn how military uniforms came into being. Cavemen had no uniform except their own hairy skins; then, as weapons grew sharper, men wore armour to protect themselves from spears and arrows. With the invention of gunpowder, fighting men relied on rough jackets, breastplates and mobility. After that stage came bright uniforms—cheering to an admiring populace no doubt, but making soldiers splendid targets for the enemy. Later, in India, a British officer, issued with white cloth for his men, tried dipping this in a muddy pool to render it less conspicuous during battle. Thus was khaki born! To-day millions of yards are used for battle dress, and it is only for ceremonial occasions that we see troops in bright colours.

GAS WARNINGS

Don't wait to enquire. *Put on mask.* Keep it on until all clear. Don't look up and risk gas in eyes. Wipe off all liquid gently. Rub ointment in gently and thoroughly. Wipe off gently. Take off gassed clothes. Wash thoroughly. Don't worry. *With a mask* gas (often a heavy liquid) is a nuisance, not a serious danger.

HOW A SEARCHLIGHT WORKS

The powerful beam of a searchlight requires a pressure of no more than 65–70 volts provided by a generator which can be driven by a lorry. Instead of being made to heat a fine wire as in the ordinary electric lamp, the high current is led to two carbons and an arc is struck. No one quite knows the nature of this arc, but it is believed that the tremendous light is due to minute particles of carbon travelling from one carbon to the other and rendered incandescent by the terrific heat—nearly 5500° F. One carbon burns away as a "crater" and the other as a point, when direct current is used. Mechanism is necessary to push the carbon forward as it slowly burns away, so that the length of the arc remains constant.

The light is reflected in parallel or nearly parallel beams by a mirror of special construction. The light strikes an aeroplane and is reflected from it back to the eye. Experts have given much attention to making aeroplanes difficult to detect in a searchlight beam—that is, to reflect as little light as possible, and to making searchlights more penetrative. Working, perhaps on the idea that the vibrations of some colours are more penetrative than others, the Germans have been experimenting with coloured searchlights, but apparently without great success.

The beam of a searchlight is like a lever—the end moves a tremendous distance for a very small movement of the pivot. When the beam is several miles long, a movement of a fraction of an inch may sweep the searchlight over hundreds of yards of sky. The difficulty of finding and holding a fast-moving plane can thus be appreciated. The searchlight's work is made easier by listening posts which, in effect, trace the nature of the line travelled by the sound waves from the aeroplane's engines and then direct the searchlight up this line. But, unfortunately, sound does not travel in quite such straight lines as light. The sound waves may be bent by differences in temperature at different levels or by reason of other factors; it is not often possible, therefore, to give the searchlight the exact bearing, the target having to be picked up by searching in a given direction.

THE BIRTH OF BIG WILLIE

In September 1918, the problem arose of how to design a caterpillar vehicle with the climbing and trench-crossing capacity demanded by G.H.Q. The problem was practically solved by Sir William Tritton and Lieut. Wilson giving the landship—it was not yet called a tank—an upturned "snout". Instead of using the whole immense circle (a wheel of not less than 15 feet diameter was required to climb the Flanders trenches), they used a segment of the circle, the rising front of the tank being, in fact, the right-hand bottom climbing corner of a huge circle.

Then another difficulty arose over the production of a suitable track. Their first real tank, "Little Willie", failed because it could not keep its tracks. They tried many alternatives, including a track of Balata belting. Then, on September 22nd 1915, they found a solution to the problem. The telegram they sent Lieut. (later Sir Albert) Stern, Secretary of the Joint Committee, admirably combined secrecy with a touch of humour: 'Balata died on the test bench this morning. New arrival by Tritton out of Pressed Plate. Light in weight but very strong. All doing well, thank you. Proud Parents.'

This tank was to become "Big Willie", the prototype of all tanks. It was originally called "H.M.S. Landship Centipede." The misleading name "tank" was not used until the vehicles first began to be made in quantity.

PARACHUTES—THE FIRST JUMP

SIMONDE LA LOUBERE (1642–1729), in his *History of Siam*, published at the end of the 17th century, tales of a person in that country who regularly made great leaps with what appear to have been two umbrellas fastened to his belt!

The earliest written record of the parachute dates from the 15th century.

Leonardo da Vinci (1452–1519) may truly be said to have invented the parachute. Mr. Ivor B. Hart in his book, *The Mechanical Investigations of Leonardo da Vinci*, gives the following extract from *Codex Atlanticus:*

"An object offers as much resistance to the air as the air does to the object. You may see that the beatings of its wings against the air supports a heavy eagle in the highest and rarest atmosphere, close to the sphere of elemental fire. Again, you may see the air in motion over the sea fill the swelling sails and drive heavily-laden ships. From these instances and the reasons given a man with wings large enough and duly connected might learn to overcome the resistance of the air, and by conquering it, succeed in

subjugating it and rising above it. (Referring, of course, to the 15th century conception of the outer universe)."

Practical parachuting coincides with the invention of the balloon, and the year 1793 is the earliest authentic date for Blanchand's first parachute jump.

SUBMARINES

THE history of the submarine in Britain dates from March 1901. Submarine A1, was completed by February 1902, and A2 a few weeks later. Britain was slow in entering the field of submarines, but once taken up they were steadily developed, and one class followed another, each an improvement on the last.

Experience gained with A boats led to the construction of the B and C classes in 1905 and 1907. Classes D and E, built in 1911–13, did magnificent work in the last war, when operations in the Dardanelles and the Baltic demonstrated the remarkably high quality of both submarines and their crews. Other classes built during the war—F, G, and H—had no outstanding features, but the J class represented another step forward in size, the displacement being 1,820 tons, with a high surface speed of 19 knots and six torpedo tubes.

THE BAYONET

THE bayonet originated in the French town of Bayonne in 1660, hence its name. The first bayonets had no edges, but were simply daggers, fixed to the gun by a plug inserted in the muzzle. This was a dangerous method, for once the order "Fix bayonets" had been given the soldiers could not fire.

It was not until some time later, following several disastrous incidents, that General Mackay invented the method of fixing which, in principle, is used to-day. It was even later that bayonets with cutting edges were used. The length of bayonets has varied enormously. British authorities believed in the long bayonet—1 ft. 4½ ins. The Austrian bayonet in

the 1914–18 war was only half this length, and the U.S.A. also prefer the short bayonet. Britain's new short bayonet now in use is the Mark IV. This bayonet has a 5-inch blade, needle sharp and very strong, with the penetration of a stiletto. It has 4 fluted sides and its narrow scabbard has a bubble on the end to protect the blade point.

THE BREN GUN

Many people wonder how the Bren gun got its name and the general answer to the question is that it is named after its inventor. Actually, the name is a composite word, made up from the initial letters of the Czech town in which it was invented and the English town in which it was perfected and manufactured. The Bren came from BRNO, in what used to be Czecho-Slovakia. It was called the Z.B. when it was first produced in 1930.

The British authorities, who were then interested in finding a really efficient light machine-gun, took it up and made improvements at the Royal Small Arms Works at Enfield. BR and EN gave Bren, which the gun was duly christened in 1934.

"JOHNNY GET YOUR GUN"

The popular cry is now "a man behind every rifle!" so it is as well to know something of the antecedents of what is likely to remain one main weapon of the foot soldier and his civilian companions for many years to come.

In the blessed years before A.D. 1300 there is no trace of fire-arms across the pages of history until one Schwarz, a German monk, used gunpowder for propelling missiles, these being arrows padded out to fit the bores of weapons. The hand-gun, as opposed to the cannon, did not come into use until the 14th century, and was then an iron tube prolonged behind into a rod which was used to manipulate it, and hitched under the arm when the piece was fired. A charge was inserted from the muzzle, and when in position,

ignited by applying a wick match to a touch-hole in the upper side of the rear end of the tube.

From this primitive weapon down to the latest Lee-Enfield rifle of to-day, the story is one of improvement of various devices for loading and firing, a vital difference between old and new being the grooving, or "rifling", which gave the hand-gun its name of rifle.

From match priming developed the flint-lock, used by the British during Marlborough and Wellington's campaigns. Then followed the wheel-lock and the percussion system of ignition, employing a detonating powder which, when hit smartly, flashed through the touch-hole and ignited the powder in the barrel.

With the percussion cap came cartridges, first of card-board, then of metal; and, with the advent of cordite, muzzle speeds increased and streamlined bullets became necessary.

Modern military rifles are now constructed to be a complete offensive and defensive arm for one man. They weigh between 9 and 10 lbs. with bayonet, and are all breechloaders with bolt system and carrying magazine. The latest U.S. Garand Automatic Rifle fires 50 or more shots a minute, is gas-operated, and can be mass-produced. Other distinctive types of rifle are the British short Lee-Enfield, German Mauser, French Lebel and Russian Nagant Three Line.

BOMBS AND GRENADES

It was the hum of missiles from early guns that earned for them the name of bombs, a corruption of the Latin *bombus*—the sound of a bee. Only in comparatively recent years has the word bomb been reserved for explosive missiles not fired from guns. The Bombardier (who, of course, gets his name from the same source) was the man who looked after the bombs fired by large guns and was not a bomber in the modern sense. The guns were sometimes called bombards, hence our word bombardment.

The name bomb is now often applied to missiles which are

more correctly hand grenades. The name grenade originated in Grenada in Spain, because the early grenades appeared to resemble the fruit called a "Grenada apple" grown there.

The Grenadiers originated in the 17th century as specialists in grenades, but the weapon went out of fashion for a long time until the last war, when it returned in a new form once widely used. Hand grenades had been used in the Russo-Japanese war of 1906, but it was the Mills bomb, named after its inventor, that brought the grenade back as a deadly weapon.

TORPEDOES

THE first torpedo was demonstrated by Robert Fulton, the pioneer of steamships. It was exceedingly crude, of course, and had to be towed to its victim by a boat. The English admirals rejected it when it was offered to them, on the grounds that, first of all, it was a method of warfare only fit for pirates, and, secondly, that as Britain had the most powerful fleet it was likely to be a dangerous weapon against her. Fulton offered his torpedo to Napoleon with little more success.

The modern torpedo was invented by Robert Whitehead, who vastly improved an invention of Captain Luppis of the Austrian Navy. Other improvements have been to the engine and the introduction of the gyroscope to keep the torpedo on its course, but substantially the torpedo remains the same. Its speeds are now up to about 40 knots and it carries a charge of 500 lb. of T.N.T. A torpedo is more effective than a shell of like weight because, since it strikes under the water, the force of the blow is greater, water being less compressible than air.

A torpedo is self-propelled, the engine being set in motion by a catch which is touched as the torpedo leaves the tube. To fire it, an initial charge of compressed air is used. When a torpedo is fired from a submarine the loss of weight is appreciable and the trim has to be adjusted.

Except when used by a submarine, the torpedo is a comparatively ineffective weapon. Several dozens have been fired in naval actions between surface ships without notable results. Among the torpedo's disadvantages are its comparatively low speed and the fact that it leaves a trail of escaping bubbles of air which mark its course.

MINES

Although many experiments with mines were made in the early 19th century and the origin of this weapon can be traced back to the old fire ships, it could not become really effective until high explosive was introduced. The bulk of an effective charge of gunpowder was too great.

The effectiveness of the mine is due to the fact that it explodes under water and the ship is hit by the incompressible water which, at the velocity of the explosion, may become almost as hard as steel. It is not necessary for a mine to be touching a ship when it explodes—magnetic mines explode well below the ship's keel, hence the unusual amount of damage they do. The effect is the same as with the depth charge which "squeezes" a submarine.

Mines are of several types. The commonest is the anchored mine, which is exploded when one of its horns is struck. The horns are of soft metal and bend to the blow. A little chamber of acid is broken and runs down into the mine to fire it. The slight delay that takes place is an advantage as it takes the mine well under the ship.

For guarding harbours, mines may be controlled. This means either that they are fired electrically when an enemy ship is seen over them, or they can be rendered harmless for the passage of friendly ships by throwing open an electric circuit.

The Germans have introduced a third type, the magnetic mine. This is laid on the sea bed and is fired by the magnetic field of any ship approaching. The remedy is to "demagnetise" all ships. This is done electrically so that the

ship has no polarity. The device is comparatively simple and is called "de-Gaussing", the Gauss being a unit of magnetism named after a famous German scientist.

A variation of the horned mine, specially used against submarines, is one with long antennæ. These cover many feet of water and overcome the difficulty that a submarine may approach at different depths to those affecting ordinary contacts.

During the last war the British laid, with their Allies, about 200,000 mines.

"BIG BERTHA"

"Big Bertha" was the name given to the German long range gun—or, more correctly, guns—which in 1918 fired on Paris from a distance of 75 miles. The casualties which resulted, even by indiscriminate firing at so huge a target, were remarkably small and nearly half of them was caused by a single shell which hit a church full of worshippers, killing and injuring about 150 people.

Here are some facts about "Big Bertha":

The barrel was a 15-inch naval gun, "tubed down" to a calibre of 8¼ inches. The length was that of a ten-storey building.

The shells weighed 228 lbs.

The muzzle velocity was 5,260 feet per second, nearly five times the speed of sound.

The shell travelled to a height of about 24 miles—only the "thinness" and lack of resistance of the atmosphere at this height made its long journey possible.

In aiming it, allowance had to be made not only for wind, temperature, humidity, barometer height, but also for the rotation of the earth during the shell's flight.

The guns wore out very rapidly and had to be re-tubed after 30 rounds; the total cost was probably not less than £100,000.

It took the French 30 hours after the fall of the first shot to

plot the position of the guns by sound ranging, and from that time, although the guns were heavily camouflaged and frequently moved, they were always found and bombarded.

During their retreat in 1918 the Germans managed to get the guns away and it is believed that certain vital parts were destroyed to prevent secrets falling into the hands of the Allies.

HOW FAR THEY FIRE

ARTILLERY can be divided, roughly, into guns with a comparatively flat trajectory and howitzers with a high trajectory. All nations keep the actual performance of their artillery a secret, but a rough guide is as follows:

6-inch gun fires 100 lb. shell 10 miles;
12-inch gun fires 1,000 lb shell 19 miles;
14-inch gun fires 1,550 lb. shell 22 miles;
8-inch howitzer fires a 200 lb. shell 7 miles;
12-inch howitzer fires a 300 lb. shell 10 miles.

Most nations have special types of artillery. The French 14·6-inch howitzer fires a 1,000 lb. shell seven miles. The remarkable howitzers with which the Germans shelled the Belgian forts in 1914 were 15·5-inch calibre, firing a 2,000 lb. shell six miles; 17-inch howitzers were later used. Each of these weapons weighed 30 tons, and it is this great increase in weight and decrease in mobility that limits the size of artillery. The difference in weight, including mountains of a turret, of 12-inch and 15-inch naval guns is represented by more than 1,000 tons. The speed and armament of vessels have to be considered in their relation to each other for special duties.

FIFTEEN MILLION A DAY

WHERE SOME OF IT GOES

IT is roughly estimated that a modern gun costs £1,500 for every inch of calibre. Thus a 3-inch gun or 18-pounder

would cost £4,500, and a 15-inch gun would cost £22,500.

EACH round from a 15-inch gun costs roughly £1,000. A torpedo costs upwards of £3,000. In a modern naval battle a score or more of torpedoes may be fired in a few minutes.

ONE minute's firing from a modern battleship costs £12,300. This figure was given by M. Campinchi, French Minister of Marine, in connection with the latest 35,000-ton *Richelieu.* This ship cost £11,400,000 or nearly double the cost of the *Dunkerque*, the 26,500-ton battleship built in 1935.

A DEPTH charge costs £35 and upwards according to size. Destroyers hunting a submarine may drop dozens in as many minutes.

A SERVICE RIFLE costs about £7; a Bren gun perhaps £30. Altogether it is estimated that each man on active service costs £600 a year. His pay, of course, is the smallest cost. It is feeding him, clothing him, and supplying him with arms and ammunition that adds up.

THE cost of an airman is about the same, if his aeroplanes are not included. With these, the cost comes to about £2,500 per head a year.

A SAILOR costs about £175 a year. But the cost of the ships works out at about an additional £500 per head.

THE total cost of the 1914–18 war has been estimated at £100,000,000,000. The South African War cost about £250,000,000. The American Civil War about £2,000,000,000.

THE ARMY

OFFICERS now only wear distinguishing marks on their shoulder straps, sleeve badges having been abolished after the 1914–18 War.

Field Marshal: Crown over crossed batons in wreath.
General: Crown over star over crossed baton and sword.
Lieut.-General: Same as General without star.
Major-General: Same as General without the crown.
Brigadier: Crown over three stars arranged in triangle.
Colonel: Crown over two stars, one above the other.
Lieut.-Colonel: Crown over one star.
Major: Crown.
Captain: Three stars, one above the other.
Lieutenant: Two stars.
2nd Lieutenant: One star.

These are in gold, except for rifle regiments which have black badges.

RANKS AT A GLANCE

(*These are given in non-technical language, with only sufficient detail to make identification easy. No doubt to the expert they would represent "incorrect dressing."*)

THE ROYAL NAVY

Rank	*Sleeve*	*Shoulder*
Admiral of the Fleet	Broad stripe with four narrow above (top one, with circle, in all naval uniforms).	Crown over G.R. over wreath.

Admiral	Broad stripe with three narrow.	Crown over sword over 3 stars.
Vice-Admiral	Broad stripe, two narrow.	Crown over sword but two stars.
Rear-Admiral and Commodore	Broad stripe, one narrow.	One star.
Captain	Four narrow stripes	Same as sleeve.
Commander	Three narrow stripes.	Same as sleeve.
Lieut.-Commander	Two narrow stripes with one very fine between.	Same as sleeve.
Lieutenant	Two narrow stripes.	Same as sleeve.
Sub-Lieutenant	One narrow stripe.	Same as sleeve.
Warrant Officer	One narrow stripe, but thinner.	Same as sleeve.
Midshipman	Three gold buttons.	White lapel with button and cord.
Cadet	Same as Midshipman.	Button and cord on lapel without white.

Wavy lines on sleeve indicate reserves.

A chief petty officer wears a crown surmounting an anchor in a wreath on his cap. Petty Officer same but anchor is in circle instead of a wreath.

THE ROYAL AIR FORCE

Marshal of the R.A.F.: Four narrow stripes above one broad.
Air Chief Marshal: Three narrow stripes above one broad.
Air Marshal: Two narrow stripes above one broad.
Air Vice-Marshal: One narrow stripe above one broad.
Air Commodore: Broad band with no narrow stripes.
Group Captain: Four narrow stripes.
Wing Commander: Three narrow stripes.
Squadron-Leader: Two narrow stripes with thin line between.

Flight-Lieutenant: Two narrow stripes.
Flying Officer: One narrow stripe.
Pilot Officer: One thin line.

These are all worn on the sleeve. No shoulder markings are used on uniforms, but on the great coat; the same markings are used on shoulder straps instead of sleeves.

The R.A.F. wings worn on the left breast indicate a pilot. A half-wing attached to a large O *indicates Observer.*—A. G., *Aerial Gunner.*

RANK BADGES OF COMMISSIONED OFFICERS OF THE U.S. ARMY

General: Four stars.
Lieut.-General: Three stars.
Major-General: Two stars.
Brig.-General: One star.
Colonel: Eagle.
Lieut.-Colonel: Silver Oak leaf.
Major: Gold Oak leaf.
Captain: Two bars.
1st Lieutenant: One silver bar.
2nd Lieutenant: One gold bar.

Insignia of rank of commissioned officers are worn on the shoulder loops of coats, overcoats and uniform shirts when latter are worn without coats. Commissioned officers wear eagle badge on front of cap.

EQUIVALENT RANKS

Navy	Army	R.A.F.
Admiral of the Fleet	Field Marshal	Marshal of the R.A.F.
Admiral	General	Air Chief Marshal
Vice-Admiral	Lieut.-General	Air Marshal
Rear-Admiral	Major-General	Air Vice-Marshal
Commodore	Brigadier	Air Commodore
Captain	Colonel	Group Captain
Commander	Lieut.-Colonel	Wing-Commander

Lieut.-Commander	Major	Squadron Leader
Lieutenant	Captain	Flight-Lieutenant
Sub-Lieutenant	Lieutenant	Flying Officer
Midshipman	Second Lieutenant	Pilot Officer

These comparisons are very limited and should not be taken too literally.

"RED TABS"

"TABS" or gorget patches are worn by Colonels and other officers above this rank. The colour of the tabs denotes the branch to which the officer belongs. Scarlet tabs indicate staff officers; cherry—medical; sky blue—engineering; pale blue—educational, and so on.

The branch to which a naval officer belongs is indicated by the colour of the cloth between the gold stripes, the executive branch being distinguished by having no coloured cloth between stripes. Examples:

Purple	.. Engineer	Dark Blue	.. Ordnance
White	.. Paymaster	Scarlet	.. Surgeon

THOSE ARMLETS!

THE armlets worn by staff officers can tell you all about them and prevent you from making mistakes. Staff officers below the rank of colonel wear armlets on the right arm, 3½ inches deep with a crown surmounted by a lion on the top half and a letter or letters on the lower half. The letters tell you to which branch they belong. For example:

G.—General Staff
Q.—Quartermaster-General's
M.S.—Military Secretary's
A.—Adjutant-General's
T.A.—Territorial Army Directorate
P.—Army Pay Corps
D.J.A.—Deputy Judge Advocate's.

Officers from Command headquarters wear a red armlet with a black stripe through the middle horizontally. The lettering is red on the black stripe.

Divisional headquarters wear an all-red armlet with black lettering. Brigade headquarters, blue armlet with black letter-

ing; garrison headquarters, green armlet with black lettering.

Letters denoting the Staff branch to which an officer belongs are as follows:

A.—Adjutant-General	A.D.C.—Aides-de-camp
A.M.S.—Assistant Military Secty.	A.Gun.—Royal Artillery
B.M.—Brigade Major	P.—Army Pay Corps
E.—Royal Engineers	S.—Signals
G.—General Staff	S.T.—Supply and Transport.
M.—Medical	etc., etc.

Officers of formations concerned with the Movement, Embarkation and Transport of Troops wear a plain white armlet.

WOMEN IN UNIFORM

How to distinguish the rank of Auxiliary Service Officers (Women):

WOMEN'S ROYAL NAVAL SERVICE

Rank *Sleeve Marking*

Chief Officer: Two thick blue braid strips and one thin, with diamond above

First Officer: Two thick strips with diamond above.

Second Officer: One blue braid strip, with diamond above.

Chief Wren: No markings on sleeve of navy blue uniform.

Wren: ditto ditto ditto

WOMEN'S AUXILIARY AIR FORCE

Company Commander: Two rings on cuff.

Company-Assistant: One ring on cuff.

Senior Section Leader: Three "stripes", like a sergeant, with crown above.

Section Leader: Three sergeant's stripes, no crown.

Airwoman, 2nd Class: No rank markings.

AUXILIARY TERRITORIAL SERVICE

Company Commandant: Three stars on shoulder.

Company Commander: Two stars on shoulder.

Company Assistant: One star on shoulder.

Section Leader: Sergeant's stripes.
Volunteer: No rank markings.

A.T.S. ranks are now very much the same as those of the whole army:

Private
Lance-Corporal
Corporal
Sergeant

The commissioned ranks are relatively:

Army		A.T.S.
Major-General	..	Chief Controller
Brigadier	..	Senior Controller
Colonel	..	Controller
Lieut.-Colonel	..	Chief Commander
Major	..	Senior Commander
Captain	..	Junior Commander
Lieutenant	..	Subaltern
2nd Lieutenant	..	2nd Subaltern

ARMY PAY

APPROXIMATE PAY IN THE SERVICES

Field Marshal	..	£1,629 per annum
Marshal of the R.A.F.	..	£1,983 (approx.) ,, plus allowances
Admiral of the Fleet	..	£2,643 ,, ,, ,, ,,

ALLIED SOLDIERS' PAY

U.S.A.	..	£12	10	0	monthly
Australia	..	£11	5	0	,,
Canada	..	£8	15	0	,,
Russia	..	£1	0	0	,,
China	..		1	5	,,

The French soldier's basic pay is (or was) only the equivalent of three-farthings a day; but he also gets cigarettes and wine, and if he is in the "artillery zone" an additional 1s. 3d. a day.

The German soldier, according to Germany, gets 12s. 6d. a week. The basic pay in Italy is 1s. 9d. a week—double that before the war. The Belgian gets 10½d. a week.

Allowances vary widely. The dependents of French soldiers get from 6s. 3d. to 17s. 2d. a week, according to where they are living, and child allowances vary from 3s. 8d. a week to 10s. 2d. The Canadian wife gets £7 15s. 6d. a month, provided the soldier contributes £4 9s. 0d. His children get £2 13s. 4d. a month. The Australian has 3s. a day extra if he is married.

INCOME TAX FOR SERVICE MEN

The exact amount payable depends upon the income you have already in addition to the amounts quoted, relatives or others dependent upon you and other circumstances. Here are basic figures:

WEEKLY INCOME.	TAX FOR YEAR.	TAX PUT TO POST-WAR CREDIT.
	Single Man	
£2	—	—
4	£34 17 0	£11 0 0
6	71 10 0	19 10 0
8	118 6 0	23 17 0
10	165 2 0	34 5 0
	Married Man—no children	
£2	—	—
4	15 17 0	14 5 0
6	45 15 0	16 10 0
8	88 6 0	28 17 0
10	135 2 0	32 7 0
	Married Man—one child	
£2	—	—
4	—	—
6	29 10 0	16 10 0
8	63 6 0	22 3 0
10	110 2 0	32 7 0
	Married Man—two children	
£2	—	—
4	—	—
6	13 5 0	13 5 0
8	43 14 0	18 15 0
10	85 2 0	32 7 0

§XI

SPORT

DARTS

No one knows the origin of the game of darts which a noted K.C. called, not long ago, "The most popular amusement in the whole of Great Britain." It may have derived in the distant past from the throwing of spears and javelins, with some features adapted from archery. In Victorian times there was a very polite version called "Indoor Archery".

Until quite recently darts was considered a "pot-house" game, and was quite unorganised. But its present popularity spread very rapidly, and in a few years the National Darts Association had 750,000 members from 12,000 clubs in 500 leagues.

The circular form of the dart board may have originated in the use of the end of a cask. Some of the oldest records of darts, going back about 120 years, in an inn in Yorkshire, show that this was the target at the time. The dart was of wood, split to take a paper flight and fitted with a stout needle.

It is now estimated that some 20,000,000 people in Great Britain play darts more or less regularly and spend £2,000,000 on the game—which does not, of course, include the price of the beers bought by the losers.

SCIENCE IN SPORT

Artillery experts can predict the exact flight of a shell fired by a gun if they know a few basic facts. The same principles can be applied to golf, or, for that matter, any ball game, but unfortunately the human body is not a machine—or perhaps fortunately. How dull it would be if we did every hole in one, never missed a penalty kick, and hit every ball for six!

But some facts about the mechanics of sport can be really helpful as well as interesting. Many of our ball games use "swerve"—the cricketer imparts it to the ball by the motion of his arm and fingers at the moment of delivery; the tennis player hits the ball with the racket at an angle instead of flat; even the footballer may make a ball swerve by kicking it on one side. In billiards, "side" is all important.

Why does the ball behave as it does? Many people have written learned mathematical treatises on the behaviour of a spinning billiard ball. Perhaps the simplest explanation of its movement to right or left when spinning about its vertical axis, as well as travelling forward, is that offered by Sir Gilbert Walker, who suggests that it is due to the "nap" giving a higher effective surface on one side which, in effect, results in the ball travelling on a slightly inclined plane.

In the case of a cricket ball it is the raised seam which causes the swerve, because there are unequal air pressures on its different sides. The air pressure tends to make the ball move in the same direction as well as forwards, due to the force imparted to it by the bowler. If we substitute the ground for the air, we find the same explanation of why a spinning ball "breaks" or moves at an angle when it strikes the ground.

For true flight, a spin about a longitudinal axis is necessary. It is to impart this spin that rifles and guns are rifled. A juggler uses this spin extensively to make his hats travel truly, and a savage imparts a longitudinal spin to his spear when he hurls it. The savage does not, of course, understand the mathematics of his action, but bases it upon experience.

Long before civilised men had learned to fly, savages had learned to throw a boomerang. Mathematicians in Europe who were working out wonderful theories of flight could have learned a lot about the effect of air currents on surfaces by watching an Australian with a boomerang. This has a section not unlike that of a modern aeroplane wing, curved on top, and in principle is the same as the rotor of an autogyro.

The course described by a boomerang depends upon its shape. A curious fact is that when the boomerang returns after having travelled perhaps 150 yards, it may be spinning faster than when it left the hand. It "gets up speed" in the same way as a rotor on an autogyro—the greater the forward movement, the flatter the "windmill".

A ball thrown into the air travels in a parabola, a wonderful figure which plays a very important part in mathematics. We know now that comets travel in parabolas, and after an astronomer has made three observations on a comet, he can plot its entire future course with certainty. Few people realise that a ball thrown straight up into the air goes up at the same speed as it comes down. This does not mean, of course, that its speed is constant. It quickly loses its velocity on its upward journey, due to friction with the air and gravity. and accelerates as it comes down, due to gravity. Theoretically there is an instant at the top of the parabola at which the ball is neither going up nor down and is therefore motionless. But the moment only lasts for a mathematically expressible period of time—far, far less than a millionth of a second. The story of the airman who found himself just on the peak of the flight of a shell and was able to put his hand out and catch it is, therefore, "tall" in more senses than one!

A ball leaves a racket or an arm at the same speed as the racket or arm is travelling. "Throwing" and dropping are actually the same thing, except that with throwing the arm is moving when the ball is dropped. In the same way a bomb when dropped from an aeroplane travelling at 300 m.p.h. is also moving forward at 300 m.p.h. But, having no engine, the bomb immediately loses its speed as a result of air resistance and falls in response to gravity. The curve of its fall is the result of a number of different forces acting at the same time—forward movement due to initial velocity, wind resistance, gravity, etc. That is why aiming a bomb is difficult.

Balls acquire a considerable velocity when struck. A driven golf ball may be travelling at 140 m.p.h. and will pass

right through a piece of wood or many pages of a telephone directory. Baseball players have caught balls dropped from a fifty-two-storey building. They were calculated to have a velocity of 138 m.p.h., and those that were missed bounced six storeys. The force was absorbed, of course, by drawing the hand back. If you could draw back quick enough, a bullet could be caught in the hand without harm. (Only "If", please note.)

A "cannon-ball" serve at tennis travels about 130 m.p.h., a fast ball at cricket may be delivered at 90 m.p.h. The speed of a really hard penalty kick at football is about 40 m.p.h.

WHAT ARE THE ODDS ?

Odds are fascinating and deceptive things. The mathematician can work out the chances and probabilities of certain events happening, if he is given certain basic facts. But it should be pointed out that the mathematical probability is not the same thing as the betting probability or odds. Fortunes have been lost at the gaming tables by men who thought they were clever because they overlooked this fact. No doubt as applied to games of chance the mathematical odds would work out all right—if you had an unlimited bank and were content to play for many years before making sure of winning!

Insurance is a more scientific form of gambling—indeed, it is not really gambling at all. The mathematician (known as an actuary) works out the odds against a person dying before a certain date and on this the insurance company bases its premium. Now if the insurance person has one client, it stands to lose, say, £1,000 immediately and can only take in the premium, say, £20 year by year. But if it has thousands or, better, millions of clients, it is true it stands to lose as much, but the probability of every person dying simultaneously is so tremendous that it can be neglected. The premium is based on the average deaths and with large numbers these work out very fairly.

The chances of four players holding each a complete suit after a pack of cards has been dealt have been calculated at—leaving out the odd millions—635,000,000,000 to 1. Someone has worked it out that this should only occur once in 44,000 years. But the curious thing is that it has happened several times in recent years alone. Is the mathematician's computation of odds wrong? No, only misunderstood. The mathematician does not say such a hand will be dealt once every so many deals, but simply that these are the odds against it being dealt in a specific deal. It may be dealt in three successive hands. It is the big win that this hand makes possible that makes it famous. Actually, for four players to pick up any given four hands is equally unlikely. In other words, when you see a specimen bridge hand in the papers, the odds against your ever holding exactly this hand are the same—635,000,000,000 to 1.

The biggest mistake in calculating the odds is to suppose that inanimate things can think. Take, for instance, tossing a penny for heads or tails. Most people suppose that after heads have turned up three times, the odds are 3 or 4 to 1 in favour of tails turning up on the next throw. It is a delusion that has made croupiers rich. The penny is not aware that heads have turned up three times. The fourth toss is a separate event which, strictly speaking, has no relationship to previous ones and cannot therefore be influenced by them. The odds on heads or tails remain "evens"—and this is equally true if heads have turned up a hundred times previously. The delusion is based on the idea that in the long run heads and tails will turn up 50-50. It is only mathematically true that the *chances* of heads and tails turning up are equal, which is a very different thing, although it might be assumed that in an infinite number of tosses heads and tails would come out equal. The greater the number of tosses the nearer to equality is the number of heads and tails likely to be, but the percentage difference in anything less than 500 tosses is quite considerable. There is nothing very

remarkable, mathematically speaking, in a test captain calling rightly five times running. There is no reason why he should not call rightly a hundred times running.

The odds of the bookmaker, of course, are not founded on mathematical chances, but partly on his knowledge and greatly on "the market"—that is, he does lightning calculations to ensure that whatever happens he comes out with a profit, however modest. He raises and reduces odds to attract or discourage custom for a particular horse or dog.

Chance, as we call it, plays a tremendous part in life. Life is a gamble in the truest sense, for the chances of any particular character being formed by the union of two cells are billions to one. Poincaré, the great mathematician, once said: "The greatest chance is the birth of a great man. It is only by chance that there occurs that meeting of two cells of different sex containing precisely, each on its side, the mysterious elements whose mutual reactions must produce the genius."

SOME ODD BETS

The longest odds paid on a British racecourse are believed to be 3,410 to 1, paid on Coole in a race at Haydock Park in 1929.

"£100 to a cigar and £100 to a match to light it," were laid against an M.P. at Windsor in 1906. The horse won and the bet paid—the odds being about 5,750,000 to 1.

£10,000 to 1 was offered and taken by a Manchester bookmaker against a dog called Denny in the Waterloo Cup in 1921. Unfortunately Denny did not oblige.

One of the biggest Derby bets is believed to be £103,000 lost by the Marquis of Hastings when Hermit won. The

owner is said to have taken £104,000. Mr. Merry, owner of Thormanby, winner in 1860, was believed to have won £500,000 on his horse.

A Winsconsin barber bet against Dempsey in his fight with Carpentier. As a result he had to pay out—a hair-cut and shave whenever required by the taker and a 50-mile car ride every Sunday for three months.

CHOOSING A CRICKET XI

Have you ever considered the real problem that faces a cricket captain? Fortunately, even the captain himself is rarely a mathematician and doesn't realise the possibilities open to him. If he has to choose an eleven from 17 possibles, he has the choice of 12,376 different elevens!

Even that does not end his troubles. He has to consider the batting order, and from 17 men in every possible combination of eleven, there are 494,000,000,000 possible arrangements—and that is leaving out an odd ten million.

SCIENCE PROVIDES A NATIONAL SPORT

Everything about a greyhound racing track is worked by electricity, except the dogs themselves. The onlookers seldom realise that the fragile electric hare is but a small part of the apparatus that drives it at speed round the track. The rails of the track are below ground level and hidden by a wooden covering from which the arm bearing the hare projects. The arm's other end is a heavy truck with flanged wheels carrying an electric motor, supplied with current by a middle rail between the wheel-rails. In fact it is a miniature electric railway wagon weighing about 1½ tons, the hare weighing only a couple of pounds. Timing is sometimes done by a photo-electric cell, such as is also used for opening automatic doors and working burglar alarms.

The dogs, some of which are worth as much as £350 to £400,

can put up good speeds. The fastest, recorded in June last year at the White City, was a measured distance of 525 yards run in 29.21 seconds by Gayhunter.

SOME SPORT RECORDS

The longest drive at golf ever made is believed to be 445 yards by E. C. Bliss at Herne Bay in 1913. The longest hit at cricket is believed to be 200 yards. Babe Ruth once hit a home run at baseball measured at 508 feet.

The longest game of chess ever played was probably one started in 1916 and finished in 1938. Two naval officers started it by post on the eve of Jutland, but after the 27th move one of the officers lost his life. Later the game was continued by the officer's daughter, who won it as stated in 1938.

Dr. Charles Hadfield in 1926 climbed the three highest mountains in Great Britain in a total of 22 hours, including travelling time. The mountains were Snowdon (3,571 feet), Sca Fell (3,210 feet) and Ben Nevis (4,406 feet).

In their match against Warwickshire in June, 1922, Hampshire made only 15 all out in their first innings. Yet they beat Warwickshire, who had scored 223, by 156 runs. The scores were Warwickshire 223, Hants 15; following on they made 186 for 6 and then the last four batsmen carried the score to 521. Warwickshire's last innings was 158. A game—or a war—is never lost until it is won.

W. Foley and T. Hutchins, of the U.S.A., kept up a rally at ping-pong which ran to 5,056 hits without the ball touching the table.

A MAN is faster over hurdles than a horse. In a race over 120 yards hurdles, T. G. TOWNS, U.S.A., Olympic hurdler, beat a crack cavalry horse by six inches.

M. POLIQUEN, of Paris, in November, 1912, swam under-water for 6 min. 30 sec. without taking a breath.

SPORT RECORDS

CRICKET

Holders of County Cricket Championship (1939)—YORKSHIRE.
Head of batting averages—W. R. HAMMOND.
Head of bowling averages—VERITY.

GOLF

Open Champion—R. BURTON.

TENNIS

Wimbledon Champion (men)—R. L. RIGGS (U.S.A.).
(women)—Miss ALICE MARBLE (U.S.A.).
Holders of Davis Cup—1939, Australia.

BILLIARDS

Open Billiards Champion—J. DAVIS.
Open Snooker Champion—J. DAVIS.

SQUASH RACKETS CHAMPIONS

Men—K. GANDAR DOWER.
Women—Miss MARGARET LUMB.

CHESS

Open Champion—Dr. ALEKINE.
British Champion—Mr. C. H. ALEXANDER.

SKATING

Amateur Champion—Miss MEGAN TAYLOR.

ROWING

Sculling, Open—H. R. PEARCE (*Australia*).

Sculling, British—E. L. PHELPS.

Oxford *v.* Cambridge, result of last three races on Thames:

1939: CAMBRIDGE won by 4 lengths in 19 min. 3 sec. (fastest time since Great War).

1938: OXFORD won by 2 lengths in 20 min. 31 sec.

1937: OXFORD won by 3 lengths in 22 min. 39 sec.

WINNERS OF FAMOUS HORSE RACES BEFORE THE WAR

THE DERBY

Year	*Horse*	*Owner*	*Jockey*	*Price*
1939	BLUE PETER	Lord Rosebery	E. Smith	7-2
1938	BOIS ROUSSEL	Hon. Peter Beatty	E. C. Elliott	20-1
1937	MID-DAY SUN	Mrs. C. B. Miller	M. Beary	100-7
1936	MAHMOUD	H.H. Aga Khan	C. Smirke	100-8
1935	BAHRAM	H.H. Aga Khan	F. Fox	5-4

ST. LEGER

Year	*Horse*	*Owner*	*Jockey*	*Price*
1939		No race due to War		
1938	SCOTTISH UNION	Mr. J. V. Rank	B. Carslake	7-1
1937	CHUMLEIGH	Lord Glanely	G. Richards	18-1
1936	BOSWELL	Mr. W. Woodward	P. Beasley	20-1
1935	BAHRAM	H.H. Aga Khan	C. Smirke	4-11

TWO THOUSAND GUINEAS

Year	*Horse*	*Owner*	*Jockey*	*Price*
1939	BLUE PETER	Lord Rosebery	E. Smith	5-1
1938	PASCH	Mr. H. Morriss	G. Richards	5-2
1937	LE KSAR	M. E. de St. Alary	Semblat	20-1
1936	PAY UP	Lord Astor	R. Dick	11-2
1935	BAHRAM	H.H. Aga Khan	F. Fox	7-2

MOTORING

Speed Record—Mr. JOHN COBB—368.85 m.p.h.

24 Hours' Record—Mr. G. E. T. EYSTON—3,578.2 miles.

Motor Boat Record

Sir Malcolm Campbell—141.74 m.p.h.

Swimming

Cross Channel Swimming—The Channel was first swum by Capt. Webb in 1875 in 21 hrs. 45 min. In recent years it has been swum many times, and swimmers include eight women. The fastest time was set up by G. Michel in 1926—11 hrs. 5 min.

100 Yards—J. Weissmuller (1927)—51 secs.

440 Yards—J. Medica (1934)—4 min. 40$\frac{4}{5}$ sec.

Mile—R. Flanagan (U.S.A.)—20 min. 57$\frac{4}{5}$ sec.

Women

100 Yards—W. Den Ouden (1934)—59$\frac{4}{5}$ sec.

400 Yards—R. Hveger (1937)—5 min. 12$\frac{4}{5}$ sec.

Mile—R. Hveger (1938)—23 min. 11$\frac{1}{2}$ sec.

Times for Record Walking and Running

Walking

One mile has been walked in 6 min. 21$\frac{1}{5}$ sec.

8 Miles 475 yards have been walked in 1 hr.

20 Miles walked in 2 hrs. 43$\frac{1}{2}$ min.

Running

100 Yards has been run in 9$\frac{3}{5}$ sec. by a man, 11 sec. by a woman.

200 Yards—record time: 20$\frac{3}{10}$ sec.

440 Yards—46$\frac{2}{5}$ sec.

$\frac{1}{2}$ Mile—1 min. 49$\frac{3}{5}$ sec.

Mile—4 min. 6$\frac{4}{5}$ sec.

One Hundred Miles has been run in 14 hrs. 22 min. 10 sec.

Marathon distance is 26 miles 385 yards—record is 2 hr. 29 min. 19$\frac{1}{5}$ sec.

Record Long Jump—26 ft. 8$\frac{1}{4}$ in., held by J. Owens (U.S.A.).

Record High Jump—6 ft. 9$\frac{3}{4}$ in.

Record Hammer Throw—189 ft. 6½ in.
Record Javelin Throw—253 ft. 4½ in.
Record 16 lb. Weight Put—57 ft. 1 in.
Record Discus Throw—174 ft. 2½ in.
Weight of Discus is 4 *lb.* 6½ *oz. Javelin* 1 *lb.* 12¼ *oz. Hammer* 16 *lb.*

ASSOCIATION FOOTBALL: INTERNATIONAL MATCHES RESULTS 1938–9

England beat rest of Europe 3–0, Norway 4–0, Rumania 2–0, drew with Italy 2–2. Scotland beat Hungary 3–1. France beat Wales 2–1.

THE Highest innings in First Class Cricket was 1,107 by VICTORIA (*v.* N.S.W.) in 1926. Highest individual score, 452 not out by D. G. BRADMAN; and highest partnership, 555 for the first wicket by SUTCLIFFE and HOLMES in 1932.

* * *

IN SPITE of intensive training, women cannot approach men in the great majority of sports and as a rule fall short by 33 to 50 per cent. A woman requires, for instance, 1 day and 14 hrs. longer to cycle from Land's End to John o' Groats, jumps 7 ft. less broad and over 1 ft. less high, requires 27 secs. start in a half-mile race, and so on.

BOXING

THE different weights at (amateur) boxing are:

Flyweight: 8 st.	*Welter:* 10 st. 7 lb.
Bantam: 8 st. 7 lb.	*Middle:* 11 st. 6 lb.
Feather: 9 st.	*Cruiser* or *Light Heavyweight:* 12 st. 6 lb.
Light: 10 st.	*Heavy:* Any weight above.

The ring for amateur boxing is roped square between 12 and 24 feet. The heavy-weight match between Dempsey and Tunney brought $2,750,000 (£550,000).

Heavy-Weight Champions of the World

1890-92—John L. Sullivan.
1892-97—James Corbett.
1897-99—Robert Fitzsimmons.
1899-1906—James J. Jeffries.
1906-8—Tommy Burns.
1908-15—Jack Johnson.
1915-18—Jess Willard.
1918-26—Jack Dempsey.
1926-28—Gene Tunney.
1929-30—Jack Sharkey.
1930-32—Max Schmelling.
1932-33—Jack Sharkey.
1933-34—Primo Carnera.
1934-35—Max Baer.
1935—James P. Braddock.
Present holder—Joe Lewis.

TEST MATCH RESULTS

England v. Australia

In Australia: Played 77. England won 34; Australia 41; Drawn 2

In England: Played 66. England won 21; Australia 16; Drawn 11

Total: Played 143. England won 55; Australia 57; Drawn 31.

England v. South Africa

In England: Played 21. England won 9; South Africa 1; Drawn 11

In South Africa: Played 43. England won 20; South Africa 11; Drawn 12

Total: Played 64. England won 29; South Africa 12; Drawn 23.

OTHER WORLD RECORDS

Thomas Cook made first tour round the world in 1872, taking 222 days.

Largest Zoo in peacetime was the London Zoo which contained some 4,000 animals, and cost £15,000 a year for food.

Biggest park in the world is the Yellowstone National Park, Wyoming U.S.A. with an area of 3,350 square miles.

Highest railway station is that of Montt, South America, which is 15,817 feet high.

§XII

CONVERSATIONS IN EIGHT LANGUAGES

Just in Case!

You might want to say any of these most important things in half a dozen or more languages, so here you are. But don't rely on the spelling, pronounced as written they sound all right:

ENGLISH:	How are you?	How's your father?	How's your sister?
FRENCH:	Comment ça va?	Comment va votre père?	Et votre sœur?
(Phonetic)	Commong sah vah?	Commong vah votr pehr?	Ay votr sir?
GERMAN:	Wie geht's?	Wie geht's Ihrem Vater?	Und Ihrer Schwester?
(Phonetic)	Vee gates?	Vee gates eerem fahter?	Oond eerer shwester?
ITALIAN:	Come sta?	Come sta il suo padre?	E la sua sorella?
(Phonetic)	Coma stah?	Coma stah eel suo padre?	Ay la suah sorella?
RUSSIAN: (Phonetic)	Kak vee pozheevietyer?	Kak vash otez?	Kak vashar sëstra?
GREEK: (Phonetic)	Pōs echeis?	Pōs echei ho patēr sou?	Pōs echei hē adelphē sou?
JAPANESE: (Phonetic)	O-ikaga desu-ka	Otosan-wa ikaga desu-ka	Go - kyodai - wa ikaga desu-ka
CHINESE: (Phonetic)	Haw laz var?	Noong kuh yar haw var?	Noong kuh tsee may haw var?

Or, again, perhaps more useful:

ENGLISH:	Please, give me a meal, a drink, a kiss.
FRENCH:	Donnez-moi un repas, à boire, un baiser.
(Phonetic)	Donnay-mwar ern repah, ah bwar, ern bezay.
GERMAN:	Geben sie mir eine Mahlzeit, was zu Trinken, einen Kuss.
(Phonetic)	Gaben zee meer ine mahltsite, vas tsoo trienken, inen kooss.
ITALIAN:	Prego, mi dia da mangare, da bere, un bacio.
(Phonetic)	Praygo, mee deeah dar manjar, dar behre, oon bahtseeo.
RUSSIAN: (Phonetic)	Pozhaluista, dizhte mnyer pokushart, veepeet shtoneebood, posceluita menyar.
GREEK: (Phonetic)	Doiēs an moi prophrōn phagein ti, piein ti, kúson me philē kephalē (kiss me sweetheart).

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ADDENDA AND CORRIGENDA

(When found make a note of)